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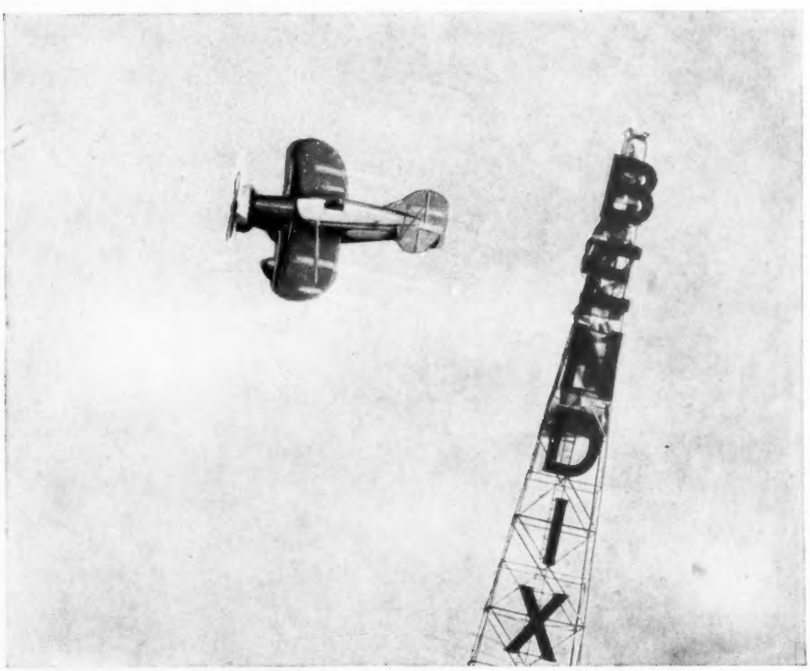


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AVIATION

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*The Oldest American Aeronautical Magazine*

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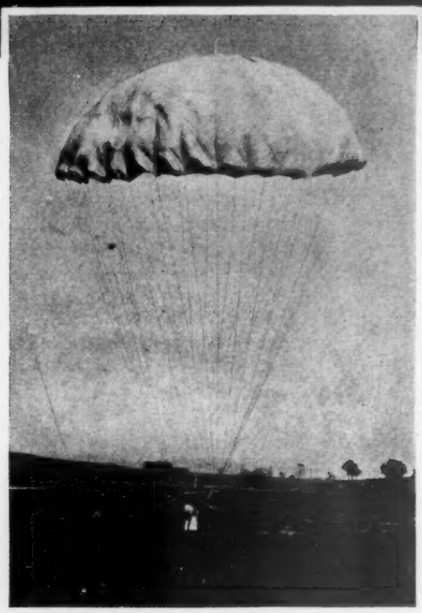

*"Setting down easily," whether one or more take to their Chutes from one ship at one time, is well illustrated in the inset picture immediately above, when the flier's feet had just touched the ground. "IRVIN" Air Chutes have been setting fliers down easily, even in the direct emergencies, for much over ten years.*

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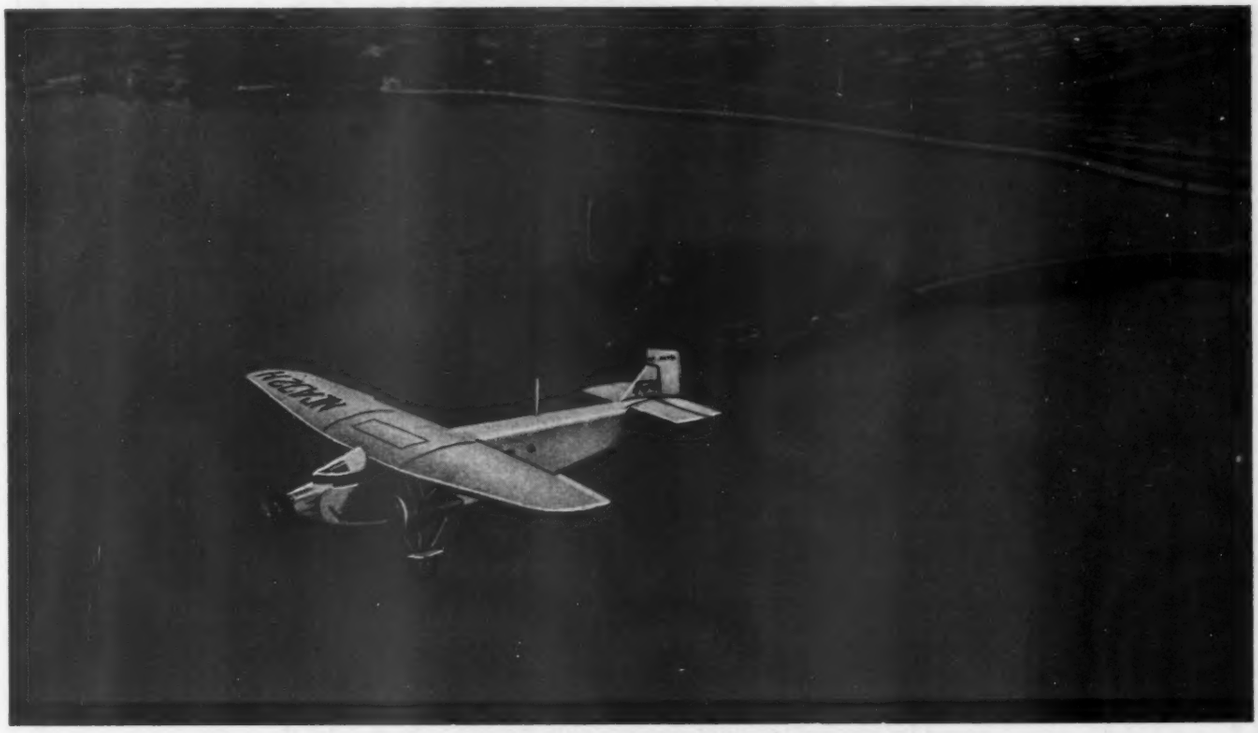


*Ford plane flying over island and 17-arch bridge in Summer Palace Lake, near Peiping (Peking)*

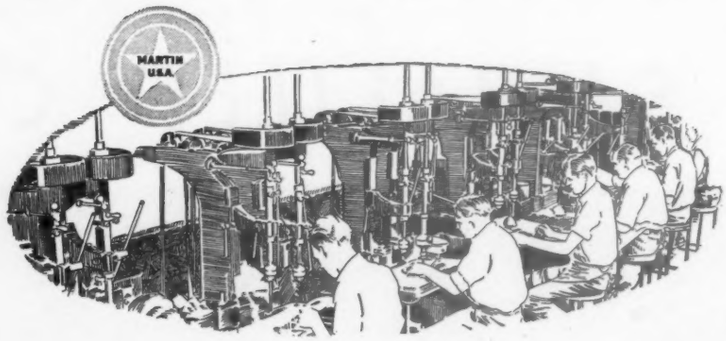
DURING the recent disturbance in China and Manchuria, daily flights between Mukden, Shanghai and Nanking were the rigorous task performed by a 5 AT Ford Transport. This plane belonged to Marshal Chang Hsueh Liang, one-time war lord of Manchuria, who had purchased it over two years ago.

The weather was unusually cold, and the landing fields and servicing facilities were far below the standards known in this country. In every way the inherent worth and sturdiness of the Ford plane were tested to the utmost. *Every day for three months the Ford transport gave reliable service and made its trips faithfully over this region of strife where the plane counted for so much.*

So satisfactory was this plane that Marshal Chang lately acquired a de luxe 5 AT transport for his personal use. The first plane after more than 2000 hours is being used nearly every day in the official business of the War Lord.

Today Marshal Chang relies on these two Ford planes for all long-distance transportation — all other means of transportation being either impossible or unreliable because of existing conditions. They are the only large tri-motor planes operated in that country. They are now stationed at Peiping. One of their most recent assignments was to fly members of the League of Nations committee investigating the Manchurian situation over the Peiping district and surrounding territory.

**FORD MOTOR COMPANY**

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AVIATION
FOR SEPTEMBER, 1932

# Speed and air races

*By Charles E. Thompson*
*President, Thompson Products, Inc.*

SOME DAY travel will be principally by air. But speed—speed with safety—is necessary.

It was a realization of this fact that prompted me to offer the Thompson Trophy two years ago as the annual award in the 100-mile free-for-all, the closed course feature of the National Air Races to be staged this year at the Cleveland Airport Aug. 27 to Sept. 5.

Speeds attained by racing seaplanes for some years have been far in excess of those reached by similar land craft. The answer is quite simple. An incentive to develop fast seaplanes was furnished by the competition for the Schneider Cup, but there was no event of corresponding importance for landplanes.

Lieut. Alford J. Williams, Navy racing pilot, attained a speed of 266.59 m.p.h. at Mitchel Field, L. I., in November, 1923. This record was broken the following year by Warrant Officer Bonnett at Istres, France, when he piloted a Ferbois monoplane over a 3-km. straight-away at 278.480 m.p.h.

It is appalling when one realizes that the speed reached by Bonnett is still the official world record for landplanes and that Williams' speed remained the American record until Lowell R. Bayles flew his Wasp powered Gee Bee over a straightaway at Detroit at 281.75 m.p.h. He failed to set a new world record under the F.A.I. rules, even though he surpassed Bonnett's speed.

Nevertheless, it is not without some pride that I can point out that Bayles' ship was designed primarily for entry in the race I happen to have sponsored. The fact that he did top Bonnett's speed and the probability that the world record will be surpassed by the planes built for the event this year is more than sufficient recompense for the time and money I have spent in fostering the Thompson Trophy.

The development of racing airplanes means the development of increased speed and safety in commercial ships. It was this way in the automobile field, and it will be the same in aviation.

Twenty-five years ago I was associated with Alexander Winton, in my opinion the most progressive of the early automobile manufacturers. At that time he was racing automobiles in various parts of the country.

We had nothing but dirt tracks then, and there is probably nothing more dangerous. One of Mr. Winton's drivers was Earl Kysor, the "Dayton Dimple" of bicycle fame. In one of the races, he went through the fence, losing a leg as a result of the accident. I remonstrated with Mr. Winton after that, saying that I thought dirt track racing was too dangerous. I have never forgotten his reply:

"It is dangerous, Thompson, and I intend giving it up. But I never put a car around the track without learning something new about it."

And it was true! The speed, the safety, the reliability of the modern automobile may be traced directly to the lessons learned in putting those early models around a dirt oval at high speeds.

The first race for the Charles E. Thompson Trophy, staged in Chicago in 1930, was won by the late Charles W. ("Speed") Holman, who averaged 201.90 m.p.h. The event last year was won by Bayles, who made good a speed of 236.239 m.p.h. I am confident that the average speed of the winning plane this year will be at least 250 m.p.h., which means that it must be capable of doing 300 m.p.h. on the straightaway.

The air race contest committee has increased the qualifying speed for the 1932 Thompson Trophy Race to 200 m.p.h. Time trials will be made over a mile straightaway in front of the stands. This course will form an integral part of a three-kilometer

**RACE PROGRAM HIGH SPOTS**

Sat., Aug. 27: Derby Day. Arrival of planes in Cord Cup, Leeds Trophy and Lawrance Trophy races.
Sun., Aug. 28: Cincinnati Derby for Yeiser Trophy.
Mon., Aug. 29: Arrival Bendix race. Speed Dashes, Closed Course Events.
Tues., Aug. 30: Douglas Trophy Race. Sohio Derby start. S.A.E. sessions, morning and evening, Hotel Statler.
Wed., Aug. 31: Phillips* and Great Lakes Trophy Races. Sohio Derby. S.A.E. sessions, morning; dinner evening, with Aero Chamber of Commerce, Hotel Statler.
Thurs., Sept. 1: Speed Dashes, Closed Course Events. A.S.M.E. and Cleveland Engineering Society joint meeting, 410 Hanna Building, Euclid Avenue. Dinner, evening at airport.
Fri., Sept. 2: Amelia Earhart Race. Detroit News Transport Race.
Sat., Sept. 3: Bellanca Trophy Race.
Sun., Sept. 4: Aerol Trophy Race.* Stinson Memorial Race.
Mon., Sept. 5: Thompson Trophy Race.*

*Date definite, others tentative at press time.



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straightaway. Those qualifying for the 100-mile closed course event will be encouraged to try for a world land-plane speed record at the same time, through the posting of a $3,500 purse by Shell Petroleum Corporation for the flier making the best time.

Outstanding among the free-for-alls is the Cleveland Pneumatic Aerol Trophy Race, the women's speed classic. The qualifying speed for this event has been set at 175 m.p.h. This is a step in the right direction. I agree with Clifford W. Henderson, managing director of the National Air Races, that the winner of the 1932 Aerol Trophy Race must maintain an average speed equalling if not exceeding the mark set by Bayles in the 1931 Thompson Trophy Race. A sum of $1,500 has been posted by the Shell Petroleum Corporation for the woman making the best time in the speed trials.

The Frank R. Phillips Race, a free-for-all for planes with engines of 800 cu.in. of piston displacement or less, likewise is of tremendous importance. This event is sponsored by the head of Phillips Petroleum Company, Bartlesville, Okla., in the hope of developing faster planes with engines of comparatively low power. It is an 80-mile closed course race for the Woolaroc Trophy.

The Vincent Bendix Trophy Race, the cross-country dash from Los Angeles to Cleveland, is another valuable contribution to the development of aviation. It is particularly so with the posting of an additional $2,500 for the flier who carries on to New York and beats the existing transcontinental record. The prize money for the race from Los Angeles to Cleveland is $15,000.

I am not implying that the events for planes holding approved type certificates are not important. The National Sweepstakes Handicap Derby, to be known as the Cord Cup Race, is a highly valuable contest. It will be run in two divisions, one starting from Washington, D. C., the other from Los Angeles. The two groups will be brought together at Bartlesville from where they will fly as one unit to Cleveland, making the largest competitive massed flight in history.

The cross-country race for the Charles Lanier Lawrance Trophy, a 36-inch bronze figure of Victory, and the cross-country handicap for the William B. Leeds Trophy, an extremely attractive cup executed by Tiffany's, are valuable also. The first will be a race from Washington, D. C., the second from Roosevelt Field, L. I., to Cleveland.

During the ten-day race period at the Cleveland Airport, a series of manufacturers' class races will be inaugurated, an added indication that the manufacturers have taken cognizance of air racing.

Among the women's races is the Earhart Trophy Race for the George Palmer Putnam Cup, an award posted by the husband of the trans-Atlantic flier.

It is my firm conviction that the cities of the future will center around airports and not waterways and railway junctions as they do now, because the airplane will be the accepted mode of travel.

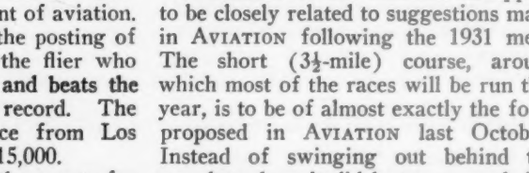
The purse for the Thompson Trophy Race is $10,000. As soon as business returns to a normal basis, I hope to increase this cash award.

•

## The race program

THE program for this year's races shows fundamental changes in almost every detail. There is a new course. The events are divided up, and the entries limited, in new ways. Handicapping is to make its appearance, for the first time in several years, and in two different forms.

A number of the innovations appear to be closely related to suggestions made in AVIATION following the 1931 meet. The short (3½-mile) course, around which most of the races will be run this year, is to be of almost exactly the form proposed in AVIATION last October. Instead of swinging out behind the grandstand, as it did last year, or being laid out so that a very wide turn at the home pylon would carry a plane across a section of the stands, as at Chicago in 1930, the course is to have one very sharp turn directly in front of the stands and two much more gentle ones about six hundred yards apart and a mile and a half to the left.




**The 3½ and 10-mile race courses.**

The program has been simplified tremendously. The total number of closed-course events listed has been reduced from 93 in 1930 (though not all of them were run) and 34 in 1931 to 28 this year. The practice of dividing machines for the A.T.C. classes into groups by engine displacement, severely criticized in AVIATION after last year's races, has been abandoned, and manufacturers' advertised speeds are substituted as a basis of classification. The separation of men and women has been dropped, except for the reservation of the Aerol and Earhart trophies for women alone. The number of free-for-alls has been reduced, and there will be no limited-class free-for-alls for any displacement above 1,000 cu.in. Machines with 400 hp. or more, and not having C licenses, will be allowed to compete only for the Bendix (trans-continental) and Thompson (closed-course unlimited) trophies. Of the 28 closed-course races, seven will be free-for-alls limited by piston displacement, four will be A.T.C. races limited by advertised speed, two will be special unlimited free-for-alls (Thompson and Aerol), and two will be for autogiros. The other thirteen include a race for the National Guard, one for OX and OXX engines, one for air transport types, five for amateur pilots, the Earhart trophy for women pilots and 685-in. engines, and four handicaps.

Two schemes of handicapping are to be tried. The cross-country derbies will be handicapped, as last year, on the basis of preliminary trial of all machines entered by neutral test pilots. There will be one handicap race for which handicaps will be arbitrarily assigned by a handicapping committee, as usual in British practice,—though a single event, cannot give the plan much of a trial. Finally, the holding of one-design class races, urged in AVIATION after last year's meet, is to be approximated in the scheduling of three contests each limited to the products of a single manufacturer,—Bellanca, Stinson, and Great Lakes, respectively. Handicaps, as among the various models, will be based on the speed as furnished by the manufacturer himself, and it will be interesting to see how many competitors, by slight refinements in their ships or by over-speeding engines, are able to show speeds in excess of the advertised figures for the type.

Most of the money will be concentrated on a few events. Five cross-country races to Cleveland will bring the winners a total of $18,250. The Thompson trophy carries $10,000, the Aerol trophy $5,000. The other closed-course events, 21 in number, show a total prize list of about $16,000.

THE UNITED STATES OF AMERICA (PART THREE)

# The equipment of air forces

*By Edward P Warner*

*Editor of* AVIATION

AERIAL bombardment in the United States started late and started slowly, but it has come fast in the home stretch. We were three years behind the other countries in giving the subject any attention at all. We were more than three years behind them in focussing our attention upon the importance of high performance in bombing planes. In the final outcome, however, there is nothing for which to apologize. American service bombers can now meet the world and ask no favors.

An agreement among the allies in 1917 left the United States free of any responsibility for the design of bombing planes. Furthermore, it left but little opportunity for American pilots to gain experience with European bombing types or tactics. The A.E.F. did some light bombing, but they had no regular heavy bombing planes and no regularly organized heavy bombing squadrons on the Western front. In the main our bombing operations were so scattered as hardly to be noticeable. When Generals Patrick and Menoher set about the creation of a well-rounded American air service after the War, they had no such body of expert and enthusiastic personnel, full of new ideas of their own, to call upon in bombardment as they could find in pursuit or observation.

### *America's first bomber*

American factories made only one war-time move toward the creation of an all-American bomber. Two months before the armistice, the Martin factory in Cleveland put out its first plane—the first of a long line of Martin bombers. The original Martin is most remarkable, not for the number that were ordered and built, but for having set a standard which was adhered to for nearly ten years. Except for changes in power plant in the last part of the decade, bombing planes showed less change in appearance between 1918 and 1928 than either pursuit or observation types.

The first order for Martins in quantity was placed late in 1919. Six years later, they still constituted the bulk of the Army's bombing material. There had been experimental submissions by other designers, notably the Curtiss and Elias Companies, but none had been bought in quantity. All of them had been very much like the Martin in general outline, and like it equipped with twin Liberty engines.

At that time the Army had its bombing problem classified as most European nations classify it still. Three categories were recognized — day bombardment, short-distance night bombardment, and long-distance night bombardment. The Martin and all its immediate rivals came in the second group. Day bombers, which were attracting a great deal of attention in Europe, were overlooked here except for an adaptation of the U.S.D-9A, or enlarged DH-4, to bombing employment, and for a single experimental project, of which more later. Long-distance night bombardment received even less attention.

To realize the point of view from which bombardment equipment developed in the years immediately following the war, it is necessary to look back again at war experience. Our forces had had relatively little contact with actual bombing operations. The British and French, on the other hand, had been watching them for four years under the highly specialized conditions of the Western front and the equally specialized conditions that attended the German attacks on London. The Germans had built a number of planes of extremely large size during the War, and on the whole they had not been particularly successful. The allies, and especially the British, acquired a certain contempt for elephantine airplanes. Bombing planes, to the French and British, had come to mean planes that could be used for attacking military installations a short distance behind the front. They had to cross the lines at very high altitudes and at reasonably high speed if there were to be a chance of getting home again without being shot down. Obviously the difficulties were much more acute by day than by night, and hence the recognition of a very definite difference between day and night bombardment machines, a difference residing mostly in performance requirements. Speed was the first specification. Bomb-carrying capacity could take a secondary place, especially on day bombers.

### *Battleship-bombing*

Our own situation was quite different. Our problem involved the prevention of successful attacks from overseas. During 1920, under the spirited spur of William Mitchell, then assistant chief of Air Service, all attention was concentrated on getting ready to attack battleships. In 1921 the first experimental attacks were made, and the Ostfriesland was sent to the bottom by 2,000-lb. bombs dropped by a squadron of eight Martins. Six-hundred-pounders proved to be comparatively ineffective against heavy vessels, and 1,100 pounders did only limited damage and the Air Service bent all its energies thereafter on getting ready to carry big bombs—the bigger the better.

From that time on, the real division in Air Service development was not so much between day and night bombers as between light and heavy machines, or between what Europeans would have denoted as heavy and ultra-heavy types. Even the light bomber, in the American philosophy, had to handle at least a 1,000-lb. projectile, whereas in England and France, with experience during the War being supplemented by experience gained in bombing the unfortified encampments of rebellious desert tribes, a bomb of 50-lb. weight was considered admirable for most purposes.

In short, when the Martin bomber first came into the Army service it was considered simply as a bomber, with no stipulation. By 1921, it had been denoted as a short-distance night bomber. In 1922 it still had the same official designation, but in practice it had been relegated to what later came to be known as the light bombardment class, and the Air Service was looking for something very much bigger.

The most famous experiment in that direction was, of course, the Barling bomber. With a gross weight of some 40,000 lb. and six Liberty engines, it overshadowed anything previously tried. Like the Do-X, it was a bold and brilliant technical conception, but it proved

to have practical weaknesses and to be too big for its job, and in the course of a year or so it disappeared into limbo.

At the other extreme of size was the Army's lone trial of a day bomber, the Gallaudet DB-1. That was a monoplane with a span of 67 ft., an 18-cylinder engine based on the Liberty and developing 700 hp., and a speed of about 125 m.p.h. Like most of the early monoplanes it had serious eccentricities of control. It went to the museum, and it was eight years before another bombing monoplane appeared on the Army's roster.

**In the beginning. Right: An Army experiment—the Barling Bomber of 1923. Above: The prototype—The Martin bomber of 1919.**

### *The Navy's plane-of-all-work*

While the Army was deliberating on the maximum size to which a bomb and the plane to carry it could be pushed, and while the officers of the Air Service were looking about for something materially better than the Martin and not finding it, the Navy was marching ahead with a succession of designs of steadily increasing promise. Work was progressing on a "three-purpose plane," adopted for long-range scouting, for bombing, and for launching torpedoes. Its basic specifications differed from those of an Army bomber principally in demanding much longer range, in providing for torpedo mechanisms as well as for bomb-racks and sights, and in laying much less stress on perfect forward vision from the bomber's cockpit. The Navy made three trials of twin-engined torpedo planes, built by Curtiss, Fokker, and Stout, respectively, in the very early days. All were monoplanes, and all were designed to be used principally as seaplanes. At least one of the three, the Curtiss product, seemed to be comparatively free from the flaws to which the monoplanes of that time were generally subject, but for some reason the Navy cut adrift from that line of development and started off in an entirely new track.

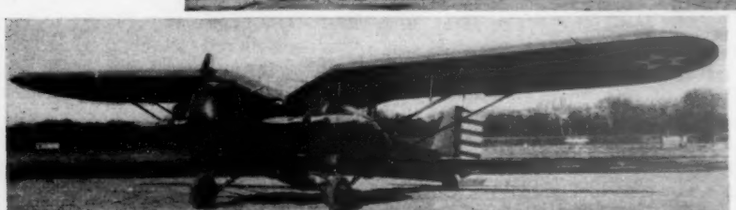
When the original Martin bomber had been designed, and while the first group of Martins were being built for the Army Air Corps, Donald W. Douglas had been the Martin Company's chief engineer. In 1921 Mr. Douglas found financial support and opened his own factory in southern California. Following a couple of experimental non-military ships, the DT-2 appeared. It was a biplane with a two-man crew and a speed of 115 m.p.h., slightly faster than the Martin. It accommodated a standard 1,700-lb Navy torpedo, and was supposed to carry it for 140 miles and return to base after dropping it.

There is little to be said of the Navy's bombing planes for the next three years except that they represented gradual improvements in adaptation to specific Naval requirements, and gradual increase in power and weight. Performance showed little change. The DT-4 and the DT-6 succeeded the DT-2. The Wright model T engine and the Packard 2500, of some 600 and 750 hp., respectively, succeeded the Liberty.

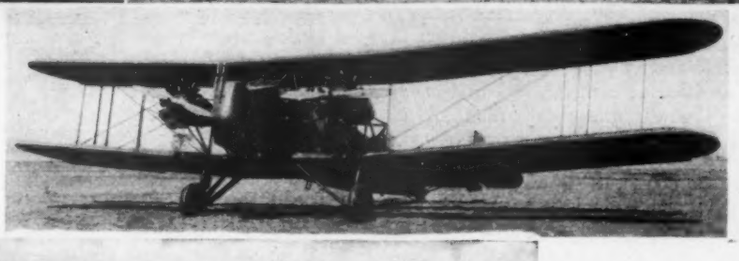
From Douglas, the Navy's choice passed to Curtiss in 1924, and the CS biplane, with a 600-hp. Wright water-cooled engine, and remarkable for having a negative overhang, with the lower wing's span exceeding that of the upper wing by some 4 ft., took a place in naval operations.

The CS and the SC were very much alike in outward appearance, but they came from different factories. Glenn Martin, after three years' work with the Army on the original Martin bomber, had turned his attention to the Navy's requirements, and from 1923 to 1930 the Martin Company built for the Navy exclusively. The SC, a production model, based on the CS of which the Curtiss company had produced a few for service test, was the first type to be contracted for after the change.

The Martin bomber made an excellent record in the Army service, but its industrial history was less happy. For various reasons occasioned by the



**A group of moderns. Above: The Boeing Y1B9. Right: The Douglas low: The Martin XB-907.**



**Bomber development 1924 to 1928. Top, left: The Keystone LB-1. Top, right: The taper wing Keystone LB-5. Center: The Keystone LB-6. Above: The heaviest service type, the Curtiss Condor.**

policy of competitive bidding then in full swing the design passed out of Martin's hands, and the Martin Company looked for some new business.

The SC series gave them a substantial amount, but still larger orders were to come. The Army had found a new source of bomber procurement by 1926, and the Martin Company was accepted as the Navy's recognized supplier of "three-purpose" airplanes. The T3M-1 and the T3M-2, with Wright and Packard engines, were the next Martins in line, and 124 of them were built in 1926 and 1927. They still preserved the essential lines of the DT-2 of four years earlier, but service experience had been adding more and more equipment and making ever-increasing demands for ruggedness. As plainly appears from the table on page 372, performance had if anything gone backward. The next Martin type marked the reversal of the trend and a new quest for performance, maneuverability, and service.

### *Keystone steps in*

We shall return to that later. In the meantime, while the Navy was turning to Martin with all its quantity orders for bombing planes, the Army was turning to Keystone. The old Huff-Daland Company (later the Keystone Company) had won a design competition and had secured an experimental order for a single-engine light bombardment plane about the 800 hp. Packard 2500 engine, in 1924. Necessarily some of the forward vision that the bomber had possessed in the Martin was sacrificed, but the parasite resistance was lowered and performance was raised. The Army bought ten of them for service test. They never bought any more, for the Keystone Company, under Army urging, swung over to the two-engined arrangement that had been standard for so long, but the single-engined LB-1 established Keystone in a field where they stayed in the top position for five years.

The twin-Liberty-engined machine was the LB-5, by designation still in the light bomber category, although its fuselage had been widened sufficiently to carry the full 2,000-lb. bomb load. The LB-5 differed from the Martin principally in the use of a thicker wing, tapered both in thickness and in chord, and in the simplification of the wing structure, with but one bay in the wing truss outside the wing engine on each side, where in the Martin there had been two. At the end of 1928 the Army had approximately 30 Martins still on hand and about the same number of LB-5's, and that was the total of Air Corps bombing equipment. In the course of the next two years, orders were placed with Keystone for an additional 137 planes. All have still kept near the original form, but with air-cooled engines of 525 hp. each substituted for the Liberties. With the exception of the change of power plant the LB-6 and LB-7 looked even more like the original Martin than had their predecessor, the LB-5, for the tapered wings had been abandoned resulting in a considerable reduction in performance. The arrangement of the latest production-model Keystone was remarkable for the sweeping back of the wings in plan form and for the use of an extraordinarily large amount of dihedral (5 deg.) and an extraordinarily large aspect ratio (9.4).

The only Army purchase from any other source than Keystone from 1924 to 1929 was a group of Curtiss Condor bombers. These machines were designed to handle a 2,500-lb. bomb load, but in emergencies or for experimental purposes they could take a 4,000 pounder. Powered with two geared Curtiss engines, they had an unusually high-performance rating. The Air Corps, however, decided to concentrate on smaller and more economical types, and after the Curtiss-Wright merger the bombing activities were centered at the Keystone plant, and the Condor was redesigned for commercial transport use.

The change of emphasis which took place in the Navy's development around 1928 has already been remarked. Up to that time, bombing and torpedo planes had been getting steadily heavier. From that point on, they began to get lighter. The T3M2, last of the water-cooled ships in the class, weighed 9,500 lb. as a bombing landplane. The T4M1, Hornet-engined, first Naval bomber to be designed especially for carrier use, weighed 2,100 lb. less. In each case the weight included a 1,000-lb. bomb and a three-man crew. The speed was increased some 5 m.p.h.

### *Dive-bombing*

While the 102 T4M1's that had been ordered as a result of the testing of the first of the line were under construction, a group of officers in the fighting squadrons and in the Bureau of Aeronautics, among whom Commanders Bruce G. Leighton, E. E. Wilson, J. E. Ostrander, and A. C. Davis and Capt. L. H. Sanderson were prominent, had been developing a new school of tactics. They had been applying the methods of aerial gunnery to aerial bombardment. Sundry pilots had recognized, immediately after the outbreak of the War in 1914, that an

airplane could be maneuvered almost as quickly as a gun could be turned on its mount, and that it was easier to aim the airplane than to aim the gun, especially where the pilot was alone in the machine. The Navy's fighting pilots in 1927 began to experiment with aiming the airplane instead of aiming the bomb. Mounting bombs of 30-100 lb. in weight on fighting and observation machines, they dove straight at their targets along trajectories lying near the vertical, and released the bomb at the last moment to continue its own course while the airplane was pulled up and away. Dive bombing proved so accurate, and seemed so likely to be immune from effective reply, since it would be only ten or twelve seconds from the attacking airplane became visible until it had released its bomb, that it was quite apparent that the new method would at least usefully supplement and might perhaps completely supplant bomb-dropping from level flight at high altitude. The present writer proposed that the method should be extended, building a machine with pursuit load factors and performance characteristics but of much larger size to permit dive-bombing with bombs large enough to do serious direct damage to an armored vessel. The first ship of that type, like the Navy's bombing-torpedo planes for several years before, came from Martin, in 1929—the XT5M1, subsequently modified into the BM1 and the BM2.

Twenty-eight of them have been purchased. No official performance figures have been released but there has been publication of their ability to handle a 1,000-lb. bomb. One model has accomplished the unprecedented feat of carrying a useful load of 41 per cent of the gross weight and still maintaining load factors high enough to permit of a vertical dive at terminal velocity and an abrupt recovery after dropping the bombs. Speeds have been stepped up considerably from those of the T4M1. Needless to say, duralumin continues to play a leading part in the construction.

The Martin dive bombers represent the Navy's last word in the class to which most attention has been devoted. On a smaller scale, however, another line of approach has been followed, occupying a position midway between the "three-purpose" type as adapted to the carrier and the patrol flying boats. A few twin-engined torpedo-bombers have been produced for assignment to Pearl Harbor and other outlying shore stations. Best known and most extensively procured of the twin-engined group is the T2D1, a Douglas product with Cyclone engines, the same weight and carrying the same bomb load as the single-engine T3M2, but making about ten miles more speed than any of the single-engined bombers except those in the diving class. Thirty of the T2D's and slight modifications thereof have been bought. Ten of them were in service in the Navy's squadrons at the end of last year, together with 87 ships of the high-altitude level-flight type with single air-cooled engines, such as the T4M1, and thirteen with water-cooled engines. The pressure for further increases in performance is strong, and Commander Mitscher told Congress this spring that the Navy has now under development a bomber that will do 189 m.p.h. at 6,000 ft.

**Table 1: Army Bombers**

| Name | Year | Engine | Horsepower | Weight (lb.) | Bomb load (lb.) | Wing loading (lb. per sq.ft.) | Maximum speed at sea-level (m.p.h.) | Service ceiling (ft.) | Range (miles) |
|---|---|---|---|---|---|---|---|---|---|
| Martin Bomber | 1919 | 2 Liberty | 800 | 10,225 | 1,040 | 9.57 | 104.8 | 10,300 | 382 |
| Curtiss NBS1 | 1922 | 2 Liberty | 800 | 12,064 | 1,797 | 10.76 | 98.7 | 8,500 | 429 |
| Curtiss Condor | 1930 | 2 Curtiss GV-1570 | 1,200 | 16,760 | 3,000 | 11.20 | 129.8 | 16,510 | 493 |
| Keystone LB-1 | 1927 | 1 Packard 2500 | 787 | 12,414 | 3,091 | 10.92 | 120.0 | 11,150 | 430 |
| Keystone LB-5 | 1929 | 2 Liberty | 800 | 12,154 | 2,312 | 10.70 | 108.4 | 7,875 | 435 |
| Keystone LB-10 | 1930 | 2 Wright R-1750B | 1,100 | 13,285 | 2,587 | 11.60 | 116.3 | 13,440 | 352 |
| Boeing Y1B9 | 1931 | 2 P & W SGIR-1860B | 1,200 | 13,351 | 2,000 | 13.99 | 188* | 22,600 | 376 |
| Douglas XB-7 | 1931 | ..... | ... | ..... | .... | ..... | ..... | ..... | ... |
| General Monoplane | 1930 | ..... | ... | ..... | .... | ..... | ..... | ..... | ... |
| Martin XB-907 | 1932 | ..... | ... | ..... | .... | ..... | ..... | ..... | ... |

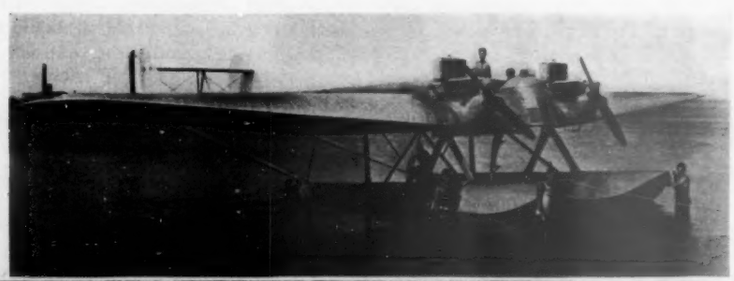
*At 6,000 ft.

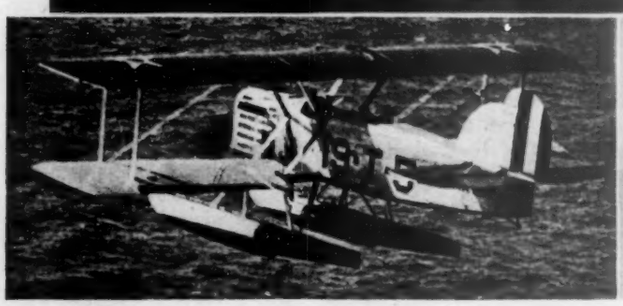
**Table 2: Navy Bombers**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CT-1 | 1921 | 2 Curtiss D12 | 700 | 11,208 | 1,446 | 13.5 | 107.0 | 5,200 | 350 |
| DT-2 | 1923 | Liberty | 400 | 7,291 | 1,835 | 10.3 | 99.5 | 7,400 | 274 |
| DT-4 | 1924 | Wright T-2 | 525 | 7,741 | 1,835 | 10.9 | 107.0 | 6,050 | 226 |
| CS-1 | 1924 | Wright T-2 | 525 | 8,629 | 1,618 | 10.1 | 100.2 | 7,050 | 468 |
| T3M-1 | 1926 | Wright T-3B | 575 | 9,725 | 1,425 | 11.4 | 104.0 | 6,270 | 525 |
| T4M-1 | 1928 | P & W R-1690 | 525 | 7,389 | 1,480 | 11.2 | 113.2 | 10,150 | 616 |
| T2D-1 | 1928 | 2 Wright R-1750 | 1,050 | 10,503 | 1,620 | 11.8 | 125.1 | 12,520 | 454 |

### *Monoplanes sweep the field*

With the Navy brought down to date, we swing back to the Army and find a tremendous change going on. In the last two years the Air Corps has definitely broken away from the tradition of biplanes with twin nacelles mounted on the lower wing. The cantilever monoplane has come into its own, and undreamed-of performance has come with it. The Army owes the new availability of the monoplane to an increased knowledge of internally braced metal





**Early Naval bombers. Left: An experimental Curtiss monoplane of 1921. Lower left: A Douglas DT-2 in flight. Below: The Curtiss CS-1 of 1924.**

wing construction, and of the cause and cure of wing flutter and other aberrations. Wing loadings have gone up, and landing speeds have consequently increased, but the resultant gains at the upper end of the performance scale have made the price worth while.

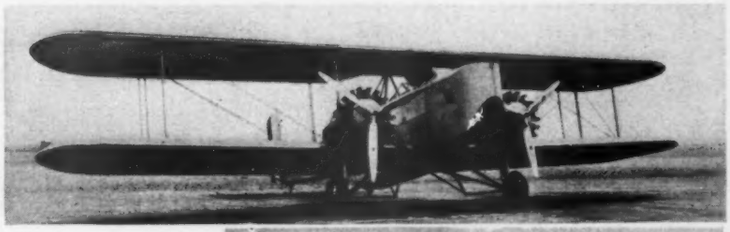
Although the monoplane has gained favor in the last couple of years in all the types that the Air Corps buys, nowhere else does it appear to have quite such marked inherent advantages as in the twin-engined bomber. The thickness of the wings permits a good mechanical arrangement for complete retraction of landing gear, and at the same time it provides a space sufficient for sinking the engine nacelles so that they add but very little to the wing resistance. For the latter possibility, the Army and the industry have to thank the National Advisory Committee's systematic work on the location of nacelles and on the selection of cowls for engines mounted on the wings. Other things being equal, the type of engine mounting that has been used on the latest bombing monoplanes is worth at least 8-12 miles an hour maximum speed as compared with the mounting of the same engine, even though equally well cowled, in a nacelle on a biplane.

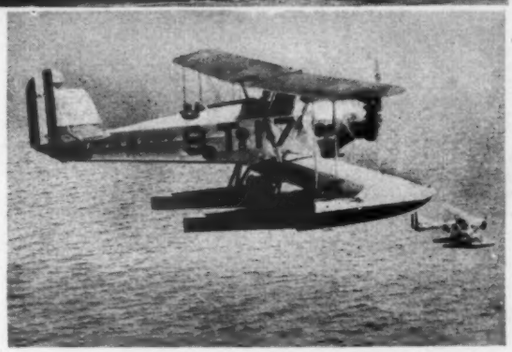
Of the four monoplane bombers, the amazing Boeing is in the heavy class. It outpaces all its predecessors, here or abroad, by some 40 m.p.h. Five examples will soon be on service test. The type has been built both with Curtiss Conqueror engines and with Hornets, and the two forms show approximately equal performance on an equal-power basis. A curious feature of the design is that the monocoque fuselage is an almost perfect cylinder over about three-quarters of its length, of constant elliptical cross-section some 5 ft. deep and 3 ft. wide. It looks more like a very early zeppelin than a modern "streamline form."

The gull-wing Douglas, and the new General Aviation and Martin designs are all monoplanes, with retracting landing gears similar to the Boeing. In all cases, the wheels are mounted on parallelogram linkages and swing back into receptacles in the under part of the nacelles. The Douglas and General models are somewhat smaller than the Boeing, and are designed for a considerably lighter military load. Very little information has been released on these machines, but they all have performance and maneuverability which would have been spectacular for a pursuit machine, and unthinkable in a bomber, two or three years ago.

### *Light bombers or heavy?*

After the bombing tests on the Naval vessels off the Virginia Capes it appeared that in the special field in which the Air Corps was most interested and most anxious to be fully prepared a 2,000-lb. bomb was definitely needed.





**Service bombers. Above: A twin-engined torpedo bomber, the Douglas T2D. Right: The Navy's plane of all work, the Martin T4M.**

Bombs of 4,000-lb. weight were actually built and dropped experimentally and the Curtiss Condor was planned to handle them, but the Army decided that such concentration was uneconomical. Late in 1927, prevailing impressions on the importance of the big bombs were confirmed when the Air Corps was given the somewhat unusual opportunity of destroying a new concrete bridge that had been completed before being adjudged an obstruction to navigation. When a 600-lb. bomb hit the bridge across the Pee Dee River it simply made a puncture, but wherever an 1,100-pounder struck it reduced a large section of the bridge structure to fragments. Hence the practice of denoting ships carrying a 1,000-lb. bomb load as "light bombers," and working from there up. In Europe, and especially in Great Britain, such planes would have been very definitely in the heavy class.

In the past two or three years, there has been not only a convergence but almost an interchange of European and American practice in this matter. The Army Air Corps is no longer interested in a super-heavy bomber. The Boeing, with its 2,000-lb. bomb load, represents the upper limit of present demand. At the same time there has been a great swing in Europe, and especially in France and Italy, toward emphasis on machines capable of carrying bombs heavy enough to wreck modern buildings when they are dropped in a city street. The whole French policy on the limitation of aerial armaments, as developed over the past year, centers on French fear of the giant bomber.

From having the largest and slowest bombers half a dozen years ago, the Army Air Corps has shifted itself into the position of having very much the fastest (possibly excepting one or two British planes, even more recent than the Boeing and probably rivaling it in speed) and, with the exception of the British, the lightest. British policy still draws a sharp line between day and night bombardment, and a typical British day bomber would be considered here as a somewhat heavy corps observation plane.

In the Naval service monoplanes suffer a general disadvantage, already noted in previous articles in connection with other types, because of their larger span and greater area occupied on carrier decks. The handicap, so far as it is a real one, is more serious for bombers than for pursuit, for the bombers' span is large at best. In the Army, however, the monoplane seems sure to triumph.

Whether diving gains further favor or not, it seems probable that the insistence on very high performance will continue in both services and that bombing strategy will place great reliance on the ability to cover 15 or 20 miles between the instant when the bombers' approach is signaled and the time when even the fastest-climbing pursuit machine could have reached them. It appears, also, that there will be no early return to the very heavy bomber, and that a 2,000-lb. bomb can be taken as the general maximum for some time to come. The pressure for heavier bombs has, of course, been weakened by the check which limitation-of-armament agreements have placed upon the gross tonnage and defensive strength of Naval vessels. In 1918 it seemed likely that post-war Naval building programs would include ships of 50,000 tons displacement, with armor heavier than any previously known, and 4,000-lb. bombs might well have been needed for attacking them. The treaties of Washington and London, however, have restricted us to ships of 35,000 tons maximum and very few of those, and much of the incentive for increasing the strength of the individual bombing unit has been removed.

THE PAN AMERICAN SYSTEM

# International transport

**¶ Ranging from mechanical details to the political relationships of nations, the problems of Pan American Airways Systems should be of interest to every domestic airplane operator. The accompanying article is based on personal observations by a member of AVIATION's staff who recently flew over some 3,000 miles of the airline.**

AIRLINE operating practices, both on the ground and in the air, are conditioned directly by the physical nature of the surface over which the route lies, the climatical characteristics, the political nature and distribution of the points of call, and the conditions under which the employees have to function. These influences are particularly striking in the case of Pan American Airways System, which operates over 22,000 miles of airways crossing hundreds of miles of open water, mountainous areas, and dense jungles, and which links with the United States 31 Latin-American countries lying in both the tropical and south temperate zones. Climate, difficulties of terrain, language differences, political barriers and national jealousies, and the limited industrial and cultural development of some of the areas traversed, all create special handicaps. Regardless of them all, the system must operate successfully all the time under the trying conditions imposed, or go out of business.

Pan American's excellent maintenance system is, therefore, matched by equally careful control of the actual flying. The same broad margin of extra care, the same demand for a high degree of skill is rigidly observed in both departments in order to assure success. As a result, the company has established, even in the trying pioneering months, one of the most remarkable reliability records of any airline in the world; and pilots and passengers regularly fly over terrain and water areas, often in the midst of severe tropical weather conditions, which would cause consternation among average airline pilots and patrons.

Time and further experience will indicate whether, and how much, the extra margin of care may be safely reduced; in the meantime no contingency is overlooked. In the first place the flying equipment is all multi-engined, and has been thoroughly tested and refined for the particular operation at hand. It has been chosen with the nature of each section in view—flying boats and amphibions for the Caribbean division, boats for the Brazilian division, and land-planes for the Mexican and Pan American-Grace divisions. Large planes are deemed expedient because of the psychological impression they have on users and future users, and for their cruising radius and comfort. The desire for larger equipment brought about the development of the Sikorsky S.41 and the huge S.40, and provided a place for the Commodore flying boats, whose only parallels in this country are the boats operated by the Navy.

### *Specialization of personnel*

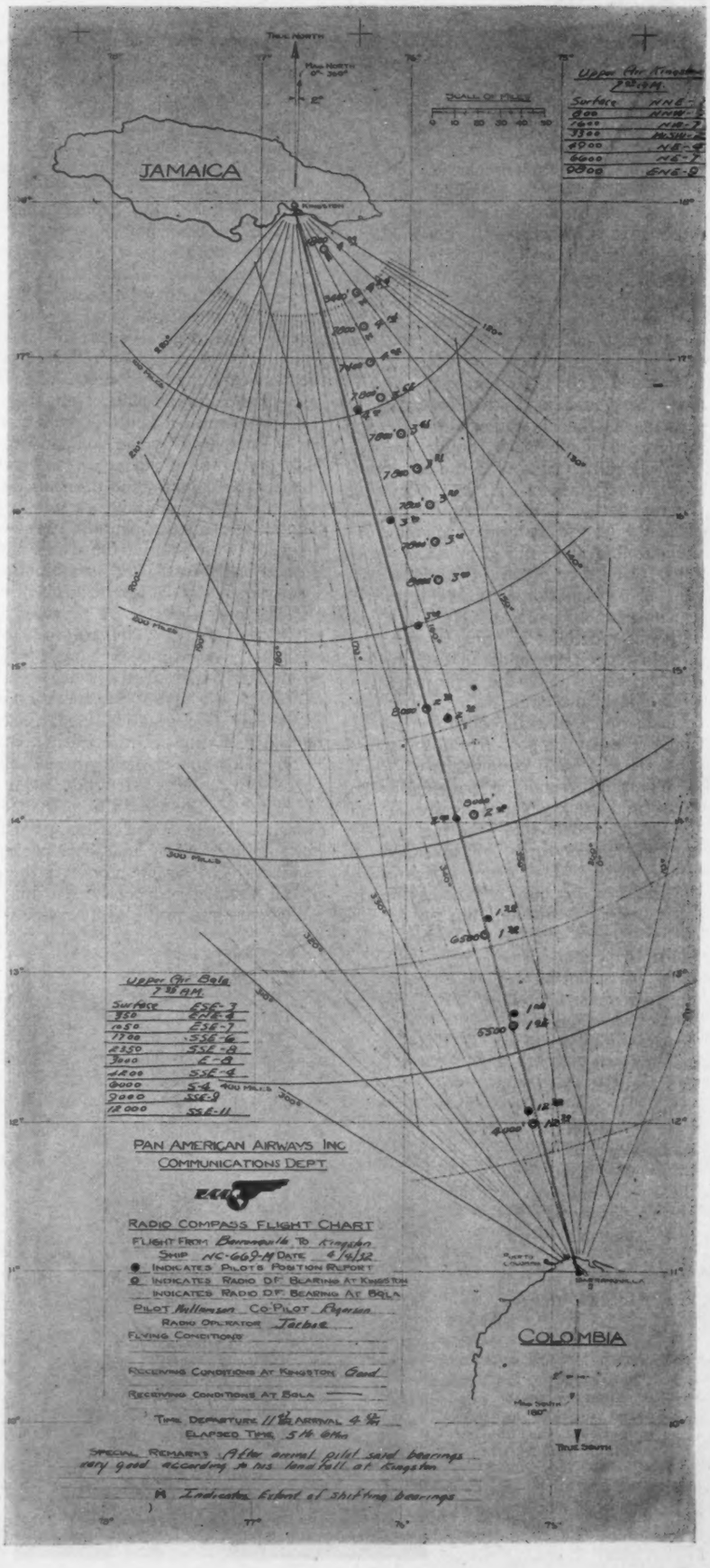
Again, the nature of the operations has induced the company to develop specialization among its personnel to an unusual degree. Responsibilities and duties are carefully defined and allotted to avoid the risk of any group or individual exceeding its capacity or losing effectiveness through fatigue, generalization of effort, or loss of prestige associated with each job.

A third fundamental operating practice is the use of two pilots on every run, with two exceptions, and even in these instances the pilot usually is accompanied by a junior pilot (not to be confused with co-pilot) or a flight mechanic who holds a Limited Commercial or Transport rating and is capable of standing his trick at the controls. The two exceptions are the Miami-Merida-San Salvador and the Barranquilla-Maracaibo-Trinidad runs, which specialize in mail and express with only light passenger patronage, and which are operated with the comparatively small S.38's.

Pan American's flying equipment has been so thoroughly tested—even to the point of extensive changes and refinements recommended to the plane manufacturers in the light of operating experience, and of the peculiar conditions imposed by extremes in climate—that the planes and power-plants are practically known quantities. The company knows what each piece of equipment can be expected to do under both usual and unusual conditions, and liberal allowances are made for coping with the unexpected. The care taken is best illustrated by the existence of absolutely inflexible weight limits for payloads for each plane and for each section on which it may be operated. The allowable payload, usually distinctly less than that allowed by the Department of Commerce, is varied only in accordance with the teachings of experience, with the change from long to shorter runs, or with the change from runs at sea-level to those requiring high-altitude flying. On the plane's clearance papers are entered the allowable maximum payload and the weight of each person, including crew, and each item placed on board, even the pilot's personal kit. Under no circumstances may the total of these items exceed the payload figure. The rule is unbreakable. Not a single pound of load is permitted beyond the company's self-imposed maximum, which assures the ability to continue in flight despite the failure of one engine.

With the reduction of the equipment to a known quantity, successful operation depends upon proper use and maintenance. Maintenance and overhaul work, and the organization of the shops, have been covered in the July issue of AVIATION. No less vital than the shop work, however, are the practices guiding the actual use of equipment on the line.

The personnel constitutes one of the company's greatest assets in that, through a very low rate of turnover,




**Copy of a Pan American radio compass flight chart from Barranquilla to Kingston. The open circles indicate the radio direction finder bearing at Kingston. The black circles indicate the pilot's position report.**

there has been built up a rare store of experience and of mature association with all ramifications of the enterprise as it has progressed. The company has developed a smooth-working, highly-trained, and intelligent organization which is close-knit in function though widely scattered geographically. It is significant that only two pilots have resigned voluntarily from the service.

The company has established four grades of pilots—the familiar senior pilot and co-pilot, and the less familiar but important grades of junior pilot and flight mechanic. Before being considered by the company a pilot must have had at least 1,500 hours, and in actual practice he usually has close to 3,000. On acceptance he becomes, of course, a co-pilot and serves in that capacity for about a year before being rated as fully qualified to take over, as soon as a senior-pilot berth becomes available, the run on which he has been co-piloting. Experience with multi-engined craft is an essential pre-requisite to employment, but experience on large flying boats, while desirable, is for the most part provided by the company while the pilot serves as co-pilot. Unusually close checks are kept on all aspects of the pilot's behavior, lest any laxity, during flight or while on the ground, jeopardize the operating standards.

No pilot, regardless of his experience, may be transferred to a new type of equipment or a new run without serving as a co-pilot for five runs and being checked out by a pilot experienced on that type of plane and that particular route.

The junior pilot is a comparatively young man with excellent education and sound flying experience, with approximately only 500 hours to his credit, who gives promise of being specially qualified to work up to the company's standards for pilots and executives. He functions for the most part as a co-pilot, but without the title and pay. This is an excellent method of bringing along a new breed of pilots thoroughly steeped in the company's practices and acquainted with the conditions obtaining throughout the system. Promotion comes when he has had about 2,000 hours, which would cover a period of three or four years.

The flight mechanic is another rating

which Pan American has created to meet its particular operating problems. While he is the holder of a Department of Commerce pilot's license, acquired before joining the company or under the express encouragement of the company while an employee, the flight mechanic is primarily a mechanic and radio operator. When carried in lieu of a co-pilot or junior pilot, he takes his turn at the stick and handles the radio. He is used on such runs as those between Miami and San Salvador and between Barranquilla and Trinidad, where no regular radio operator is carried and where the airports are so unimportant from a traffic point of view as to need only one or two servicing attendants. The flight mechanic's primary responsibility, therefore, is to function as the chief mechanic at each airport his plane visits, doing the mechanical adjustments with the assistance of the local staff as well as supervising the regular servicing, warming up and housing, in the customary manner of the co-pilot and junior pilot on other runs. In other words, the plane carries its own mechanic where it cannot depend upon a local staff. He is credited with one-fourth of his time at the stick as solo time if he holds an L.C. rating, one-half if he holds the Transport.

The flight mechanic on a Clipper performs a duty new in scheduled operations. He has his post behind the senior pilot in the same compartment, which is separated from the passenger sections, and observes practically all but the flying instruments—the fuel gauges, engines temperatures, oil pressure and temperature. He even synchronizes the engines, but never handles the flying controls. Without him on a plane of the Clipper size the multiplicity and inevitable distribution of the instruments would create an almost impossible, and certainly an undesirable, burden for the pilot. The same practice, of having a mechanic responsible for everything connected with the functioning of the power-plants is followed on the Dornier Do.X.

Pan American uses larger crews than is customary on domestic lines. Their size and composition vary with the type of equipment and the consequent need of distributing responsibilities. Besides the flying personnel already mentioned, the company employs regular radio operators and stewards. In fact, Pan American was the first of the major lines to use stewards regularly on its larger planes.

Back of the crew organization are the same general conditions outlined in regard to operations—the need of making generous allowances in each function for satisfactory performances even under extreme stress and consideration of the psychological effect of patrons, potential patrons and on all with whom the service comes in contact. The pilot is in charge of the plane from the time it takes off until it lands at its next stop. He is compared by the company to the deck officer of a surface vessel rather than to the captain, the division operations manager retaining certain of the functions of the sea captain. However, the pilot is the man at the wheel and he is specifically instructed to maintain the dignity of his office and to keep in mind his responsibilities as a representative of the company. The co-pilot is his right-hand man and exchanges regular 30-minute tricks at the controls. Because of the crew organization, the pilots can give practically all their attention to flying and navigating.

The pilots are not encouraged to converse with the passengers, who are cared for by the stewards, provided expressly to answer the questions usually put to pilots and to look after passenger comfort. This practise relieves the pilot of all detailed concern regarding his passengers and provides a service which adds much to the satisfaction of passengers, especially on the long hops characteristic of the system.

Nor need the pilot give the radio a second's thought. Everything connected therewith is handled by the experienced operator, who is qualified to make spot adjustments in case anything goes awry with the instrument. The matter of spot repairs is a vital one in an emergency situation. The pilot merely has to write out his periodic reports and other messages and hand them back to the operator for transmission, and to read the reports transmitted to him from the ground. The policies of carrying a specialist and of using radio telegraph instead of radiophone were determined upon early in the company's history and have worked out with notable success. One of the greatest advantages is that a complete record is assured of all communications, however slight. The company is satisfied, also, that radio-telegraph communication is much faster and more accurate while the range is much better than could be secured with radiophone. Radiophone communications in the face of tropical static present great difficulties, and code has the additional advantage of permitting "working" with ships at sea.

The Clippers carry the largest crews —pilot, co-pilot, flight mechanic, in this instance often referred to as flight engineer, radio operator, and steward. The same complement, without the flight mechanic, is carried on the Commodores, the S.41's and the tri-engined land equipment. The S.38 crews, because of their size and the small amount of passenger traffic on the runs where they are used, normally include only a flight mechanic-radio operator in addition to the senior pilot.

**A Sikorsky S-40 prepared to take on passengers at the floating seaplane base at Dinner Key.**

### *On the ground*

The ground organization at each point of call along the line, exclusive of the traffic representatives concentrated for the most part in the more important communities, is under the control of an airport manager. His diversified responsibilities include weather observation (even upper air in some cases), the supervision of servicing, communications, receiving and despatching passengers, mail and express, and handling of clearance papers and documentary work. He may have a staff of assistants or operate alone, depending upon the volume of traffic through his domain. Some of the managers of South or Central America, and many of them are natives, have flying experience, though that is not essential. At a main station, such as Miami the base manager has charge of all operations clearing through the terminal itself, as distinguished from the broader administrative activities of all departments which are carried on at that point.

A plane comes under the jurisdiction

of the airport manager as soon as it lands. He assembles the multitude of papers, sees that all baggage is stowed, receives and despatches all mail and express, routes incoming and departing passengers, supervises servicing, clears the weather information and operating orders, and gives the order for departure. The port manager, or the pilot, or the division operations manager has the authority to cancel a flight or postpone it. A decision by any one of these three is final. A written explanation of the reasons for the decision is required, but only for purposes of record.

Ground operations are complicated by the vast amount of paper work required by the international customs and immigration practices. The bulk of this work consists of preparation of clearance papers similar to those which must accompany marine vessels. Because of the need to make the customs and immigration routines as efficient as possible, special attention has been paid to reduction of time and process required, and to mastering the regulations in effect at each point of call. The clearance clerks at the busy Miami base are allowed only 30 minutes preceding the departure of a scheduled flight to complete the complicated forms. Customs, immigration, and health formalities are handled by experienced personnel in such a way that not more than 15-20 minutes are required to clear passengers through the busy Miami station. Even though the company has secured a valuable simplification in clearance practices, as compared with those still in effect in marine operations, the preparation of clearances costs the company about $300,000 a year, and the Carribean division alone about $96,000.

Not the least of Pan American's operating problems has been the installation and maintenance of suitable land and marine bases and aids to air navigation. In its territory there is no federal airway system. In practically every case the company has been forced to install and maintain its own terminal equipment, consisting of more than 90 airports and flying boat bases, usually at great expense and often under great physical difficulties. The field at Merida, for instance, has a rock foundation which had to be blasted to provide suitable runways. Jungle terrain, low coastal areas, river currents and local politics all contribute complications in the installation and operation of the airports. There are no intermediate landing fields as we know them in this country, though the company has inspected and approved "emergency" landing areas which are known to the pilots but which are not marked.

### *Instruments*

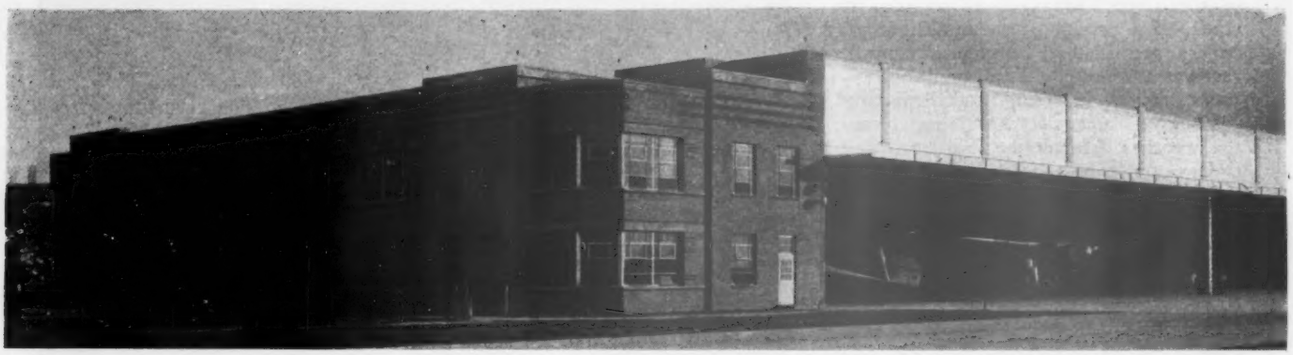
Instrument flying is an every day practice on a number of sections. Without the use of "blind" flying instruments many schedules could not be kept. Probably the most constant users of instruments are the Mexican division pilots, who regularly encounter tropical rain and fog in the low lands of Yucatan and clouds in the mountain areas and have to climb up through thick cloudbanks to get to the high plateau where Mexico City is located. Knowledge of the characteristics of the weather from long personal experience, buttressed by the instruments and constant radio contacts regarding visibility and the ceiling conditions at terminals, enables pilots and operations managers to employ instrument flying as a nominal phase of operations. Instruments are used regularly for climbing or descending through fog or cloud strata, which often are so thick that an hour is spent in the gentle ascent or descent. It is not at all unusual for the pilot to depend on instruments for at least two hours on a normal trip. On the Mexican division instrument flying is in a comparatively advanced stage, and the degree to which instruments are depended upon, and the skill with which they are used, is particularly significant in view of the inhospitable terrain over which the planes are flown. Instruction and practice is provided by a Fairchild FC 2 with cabin windows of glazed glass to simulate cloud conditions. Graduates of the basic blind-flying course continue their training on the larger line equipment. No attempt is made to land blind, of course; the visibility must remain satisfactory for a landing at the destination, or the plane is turned back. No division of Pan American does scheduled night flying, largely because of the need to clear customs at least a half hour before sunset.

**Runways on the field of the Merida Pan American base were constructed on a foundation blasted out of solid rock**

### *Radio aids*

The absence of federal airways in the countries served by the system means, also, of course, the absence of a free direction finding aid, such as the radio range beacon which has been provided by the U. S. Government. Pan American needs such an aid and has provided the radio direction finder, selected and developed as the best suited for its purposes, after investigation of all available types. It has a wide range (about 600 miles) as compared with the radio range beacon, which is limited to about 100 miles. It is less expensive, works best with the radio telegraph system adopted by the company for communication and involves no additional installation on the aircraft, not even a loop. The equipment is concentrated at terminals, the operators on the shore take the radio bearings and inform the pilot on the plane by radio of his position.

The most used unit at the present time is that at Kingston for the guidance of planes on the Kingston-Barranquilla route. There is an installation at Barranquilla, also, and others are being placed at strategic points. It has been found entirely reliable and fast in operation. Planes on the Barranquilla-Kingston run, for instance, can be navigated along a very accurate course over that all-water route with safety and with high operating efficiency and economy. The pilot reports his position every 30 minutes from dead reckoning. As the contact between plane and ground is being made, the radio direction finder operator gets a bearing and radios the true postion as shown by the finder. The pilot then checks his own navigation in accordance with the indications of the direction finder. A record is kept on individual maps for each run of the positions reported by the pilot from his own navigation and those shown by the finder readings. Comparisons of the two provide material for an analysis of a pilot's personal errors as a navigator and of the influences of meteorological conditions on the behavior of navigating instruments. There is a general tendency for pilots actually to fly to the right of the true course.



THE FOURTH ARTICLE OF A SERIES ON MAINTENANCE

# Concentrating maintenance for efficiency

## T.&W.A.'s new operating base at Kansas City

*By S. Paul Johnston*
*Assistant Editor of* AVIATION

MANY airline maintenance shops, in common with the majority of plants in other industries of far greater antiquity, partake of the unfortunate situation of Uncle Tom's dusky Topsy. They had no bringing up, they "just growed." Even as late as two or three years ago the maintenance requirements for an airline were so nebulous that operators were reluctant to put a great deal of money into expensive overhaul or servicing plants. For the most part, they made the best use they could of the hangars in which they had started their operations, making parasitic additions to the building proper, or putting up casual sheds in the immediate vicinity as they outgrew their quarters. Often the result has been a hit-or-miss collection of structures and a consequent confusion and discontinuity of processes which have militated against efficiency and economy. Current economic difficulties have retarded the betterment of conditions. Money has been scarce, and it is only natural that operators have felt that they lacked justification for scrapping existing plants and reorganizing their buildings and equipment in a more efficient way.

In spite of hard times the operating heads of Transcontinental & Western Air, Inc., concluded that their best interests would be served by establishing operating headquarters and a thoroughly modern maintenance plant at about the geographical center of their system. Accordingly, they combined operating experience accumulated in the several years of operation on Transcontinental Air Transport and Western Air Express with sound industrial engineering practice in the erection at Kansas City, Mo., of a magnificent unit housing under one roof all shops and offices required for the supervision of all their lines. Much of the credit for this development is due to the foresight and energy of Jack Frye, vice-president in charge of operations of T.&W.A., and to the long and intimate association with the repair of airplanes and engines of his able superintendent of maintenance, W. A. Hamilton.

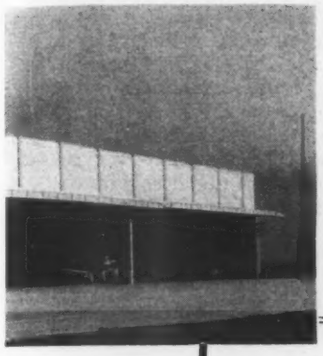
### *Two types of maintenance systems*

Two distinctly different types of maintenance organization have appeared on American airlines. The first may be defined as the divisional system, where two or more distinct sections of an airline are operated as complete units within themselves, incorporating the complete functions of a separate system. The United Air Lines maintenance scheme described in the August, 1932, issue of AVIATION, is a typical example. The divisional type of organization is the logical result of the formation of large airway systems by the merger and absorption of established independent lines. It has been only recently that there has been any disposition to abandon the divisional system and set up a centralized operating and maintenance headquarters.

The latter type of organization is represented by the present set-up of Transcontinental and Western Air. The equipment and personnel of the former Transcontinental & Western Air repair bases at Glendale and Columbus were moved to Kansas City upon the completion of the new buildings late in 1931, and the two former overhaul centers are now maintained only as servicing points.

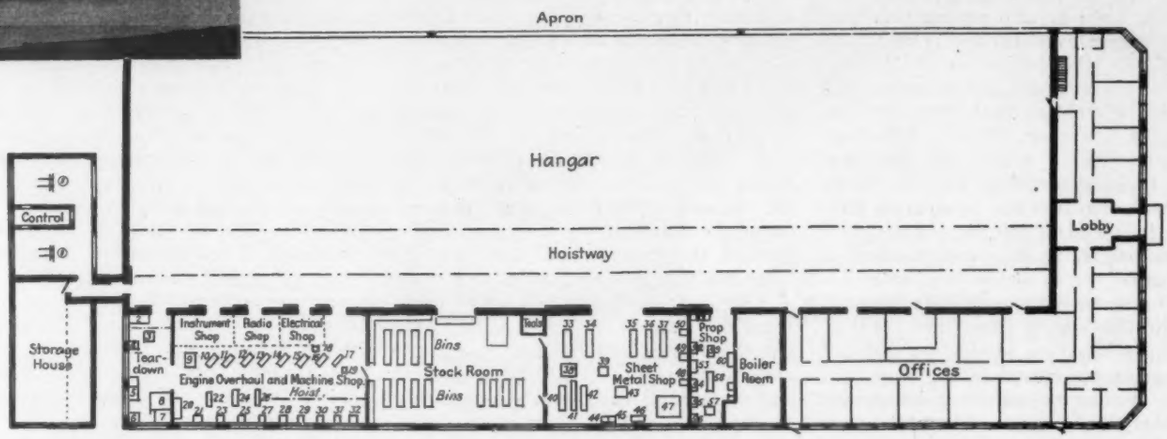
The principal executive offices of Richard W. Robbins, president of T.&W.A. are located in New York City. Mr. Robbins divides his time between these offices and the operations base at Kansas City. T. B. Clement, vice-president in charge of traffic makes his headquarters in New York, as does Maj. W. J. Barry, secretary and treasurer. Jack Frye, vice-president in charge of operations; F. G. Wilson, comptroller; and W. C. Buchterkirchen, purchasing agent, are based at Kansas City. The heads of these five departments report direct to the president.

Most of the active flying equipment of T.&W.A. is of all-metal construction. The principal passenger-carrying equipment consists of seventeen model 5AT Fords, supplemented by four Fokker F-10S. Seven Consolidated Fleetsters are soon to be added to the roster. Ten Northrop Alphas constitute the principal mail-carrying equipment. In addition, there are on hand for various purposes (mostly for reserve) four Lockheed Vegas, two Fokker F-14, one Stearman biplane (which is used for blind flying instruction), and two model 4AT Fords. The power plant in-



**T & W. A. offices and hangar (left) and (below) layout of the shops and hangar.**

1. Engine run-in stands; 2. Tear down bench; 3. Spray rack; 4. Buffer; 5. Turco tanks; 6. Paint spray booth; 7. Pangborn sand blaster; 8. Drying oven; 9. Heald cylinder grinder; 10. P.&W. 16-in. lathe; 11. Monarch 16-in. lathe; 12. P.&W. internal grinder; 13. Heald 75A grinder; 14. Aurora drill press; 15. Cincinnati milling machine; 16. Canedy-Otto drill press; 17. LeBlond grinder; 18. Heald surface grinder; 19. Rapid Cut hacksaw; 20-21. Inspection benches; 22. Bench and drill press; 23-25. Benches; 26-31. Rod benches; 32. Lapping table; 33-35. Sheet metal benches; 36-37. Welding benches; 38. Pexto squaring shear; 39. Myer corrugator; 40. Dreis and Crump brake; 41. Northrop fuselage jig; 42. Myer brake; 43. Scroll machine; 44. Pettingil hammer; 45. B&D grinder; 46. Westinghouse heating vat; 47. Water vat; 48. Niagara shear; 49. Wilson hydraulic press; 50. Marvel hacksaw; 51. Tungar battery charger; 53. Blade racks; 53-56. Caustic acid and water vats; 57. Polishing table; 58. Surface table; 59. Balance; 60. Hydraulic press.




ventory of engines both in active and reserve service consists of 126 Pratt & Whitney Wasps, 25 Pratt & Whitney Hornets, 6 Wright J-5S, and 11 Wright J-6S.

The central location of the maintenance shop makes it possible to work out uniform schedules for inspection and servicing of the flying equipment. Planes leaving Kansas City in the morning reach Newark and Glendale in the late afternoon, returning within one or two days. They thus reach a terminal at the end of about twelve hours of flying and are back at the repair base after 24 or 25 flying-hours. Inspection and maintenance schedules are worked out on a 25, 50 and 100-hour basis, although thorough intermediate inspections are made at Columbus and at Alburquerque as each plane goes through. The 25 and 50-hour inspections cover the usual ground. Special forms are supplied to the mechanics, listing the various parts of the airplane and engine which are to be given special attention and which must be initiated after the work is completed. Lubricating oil is drained every 50 hours. Push rods are removed for inspection every 50 hours, and are lubricated in place about every 12 hours of flying.

The shop and servicing unit in its location on the municipal field at Kansas City, in close proximity to the airline terminal building, offers the maximum convenience in delivering or receiving airplanes to or from active service. Ships may be fueled and engines run up on the hangar apron just prior to taxiing over to the terminal building scarcely a hundred yards away. Incoming planes discharge their passengers and are immediately moved to the apron for refueling, checking and servicing. The shops and offices themselves represent probably the most modern airline maintenance plant in this country. The building, which covers about three acres of ground on the airport, is of brick, steel, concrete and glass construction.

The principal portion of the building is the hangar, a single room about 120 ft. wide and 400 ft. long, with unobstructed floor space. One entire side is taken up by three canopy type doors, each 130 ft. wide. Thus with 22 ft. of headroom throughout, the hangar is able to accommodate the largest airplane in commercial use today. In the northeast corner and along part of the north side, the hangar proper is backed up by a two-story building which houses all the operating offices, and the individual shops occupy a lean-to some 50 ft. wide running along the back of the hangar for its entire length.

Great care has been expended in making all repair departments immediately accessible to the hangar. For example, the instrument, radio and electric repair shops, although located in the engine overhaul shop, open into the main hangar on one side and into the engine shop on the other. The stockroom is also in a central location.

### *The servicing hangar*

The servicing hangar is fitted with a wide variety of stands and platforms. The most notable apparatus of this nature is a three-section portable platform which can be pushed in place around the nose and nacelles of a three-engined plane to permit mechanics to work conveniently. It has been estimated that the use of this stand has resulted in a saving of time of from two to three hours on a tri-motor engine installation job. Probably the most useful single piece of equipment in the servicing hangar is an overhead hoist equipped with chain falls operated from the floor, which permit the easy removal of engines or the dismantling of airplanes.

Practically all airplane overhaul jobs involve the sheet metal shop. This shop is equipped to handle anything in the way of fuselage or wing repair, or the manufacture of cowling, exhaust pipes, etc. A variety of metal-forming tools are on hand, as well as complete welding equipment. Due to the special problems involved in the maintenance of all-metal airplanes new methods and tools have had to be developed, for example, a large structural steel jig has been set up which will handle a complete fuselage for a Northrop Alpha.

### *Procedure with engines*

The engine shop at the T.&W.A. base at Kansas City certainly ranks high among the most beautifully laid out and the most thoroughly equipped in the country. It occupies a space of approximately 40x90 ft. at the south end of the lean-to. A partition across the north end separates the tear-down and cleaning room from other operations. The shop proper houses engine

inspection and reassembly, as well as the machine shop, the instrument and radio repair shop, and the electrical repair shop. Instrument and radio shops, although located physically within the engine overhaul, come under the supervision of the radio department proper. Electrical repairs, however, which include the overhaul of generators, starters, spark plugs and ignition wiring, come under the supervision of the general shop foreman. The machine shop is also an integral part of the engine overhaul and is controlled directly by the engine overhaul foreman. This contrasts, for example, with the arrangement at the United Air Line Shops at Cheyenne, Wyo. (AVIATION, August, 1932), where the electrical shop, the machine shop, and the engine overhaul shop function as separate units under independent foremen, all of whom report directly to the superintendent of overhaul.

In common with practically all modern air line engine shops, the T.&W.A. system is based on production methods.

Engines are moved to the shop from either storage or servicing hangar on a rubber-tired buggy. After tear down and cleaning, all parts are put on steel racks of more or less familiar form. Each has sufficient space to accommodate all parts for any one engine except the cylinders.

Cylinders are first dipped in Turco cleaning compound to remove grease and oil, and then after the intake and exhaust parts and the valve housing have been covered up with suitable plates they are sand blasted in a Pangborn sand blasting machine to remove all old enamel. After they are thoroughly cleaned they are transferred to a paint spray booth, where one coat of oven-drying enamel is applied by means of an air brush. The painted cylinders are then placed on buggies designed to carry the cylinders and the intake manifold pipes. The buggies serve not only to transport the cylinders into the shop but also go into the enameling oven, eliminating transfer of painted cylinders to oven racks.

All other engine parts are thoroughly cleaned either by dipping into Turco cleaning compound of a proper composition, or by spraying with light petroleum spirits. After thorough cleaning all parts are inspected and started through the engine shop for assembly. The parts racks progress down the center of the shop. Work benches for the various operations are lined up down the room at right angles to the flow of the engines, and the men responsible for each separate sub-assembly or unit simply take the necessary parts from the rack as it passes their bench, put them into proper shape in accordance with original factory tolerances and restore the completed sub-assembly to the parts rack. Each work bench is provided with all the tools necessary for the completion of any particular operation assigned to that station. By the time an engine rack has progressed about half way down the shop all sub-assemblies are complete and final assembly begins. Standard Continental assembly stands are used.

Worn cylinders are reground on a Heald grinder in the machine shop. Two oversize standards are used, i.e., 0.010 in. and 0.020 in. The 0.010-in. cylinders are identified with an orange color band around the lower part of the shell, and the 0.020-in. cylinders by a green band in the same location. Cylinders are further identified by the actual amount of the oversize stamped into the edges of the base flanges.

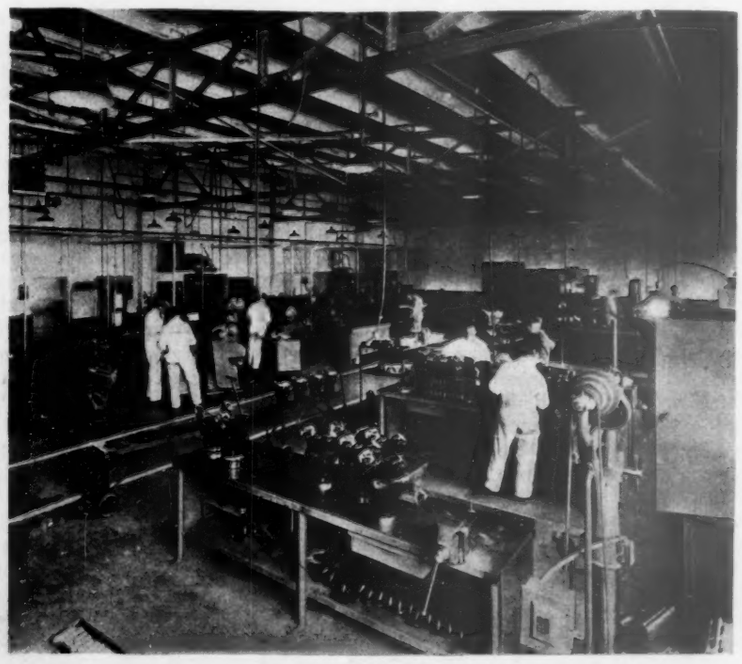
Piston rings are replaced at every engine overhaul. In radial engines the torque tends to cause more wear on one side of each piston than on the other, which in turn results in unequal wear in the piston ring grooves. In order to balance out the wear on pistons it is the practice of the T.&W.A. shops to replace the pistons after every overhaul 180 deg. from their former position in the cylinder. Since pistons are usually placed so that the stamped-on piston numbers are forward, the numbers are changed on the piston heads from one side to another at every overhaul.

B.G. radio shielded spark plugs are now standard equipment on all engines. They are pulled for cleaning every 25 hours and after 50 hours are sent to the shop for complete tear down, cleaning and testing. The average life of a plug is about 600 flying-hours. One man can take care of about twenty sets of spark plugs per day.

Practically all of the ignition shielding used on T.&W.A.'s planes is the type designed by W. A. Hamilton, the system maintenance superintendent, and now being manufactured in Los Angeles, Cal. The Hamilton shielding differs from the Breeze or Rome types in that there are two complete systems of conduit—one for each magneto and set of plugs. The two main loom housings of aluminum are mounted on the crankcase—one forward of the cylinders, and one aft. Connections to the magnetos are made through flexible conduit. One interesting feature which has recently been introduced is the replacement of the flexible spark plug lead with a rigid tube gooseneck. The necessary flexibility for installation or removal is obtained by the use of a cone seat coupling at the point where the lead enters the main conduit. All wiring in the harnesses is replaced at every engine overhaul.

Complete overhaul of an aircraft engine at the present time requires about 112 man-hours, including an eight-hour test. It takes about one day for any engine to pass through a particular group of operations, for example, one day to tear down, one day to clean, one day to inspect, one day to assemble, and one day to test. In general, the overhaul time for several of the accessories is as follows: Generators, 6 man-hours, magnetos, 2 man-hours; carburetors, 6 man-hours; ignition harnesses, 5½ man-hours.

The run-in of engines after overhaul is conducted in a small building separated from the main hangar. Eight-hours under varying throttle conditions is put on every engine before it is released for service.



**General view of the engine overhaul shop.**

Above, left: The cool and spacious waiting room in Pan American Airways' terminal at Brownsville, Texas. The wrought iron screen in the background symbolizes the route over the mountains into Mexico City. Above, right: Marked similarity to modern railway station practice characterizes the interior of the new airline terminal building at Tulsa, Okla. The bronze panel surrounding the clock depicting modern transportation, is worthy of note.

# For him who waits

Above: A group of passengers waiting to board planes at the United Air Line terminal at Los Angeles. This busy station handles the heavy West Coast and transcontinental traffic with ease and dispatch. Left: The comfortable and efficient waiting room and ticket office of Eastern Air Transport's northern terminal at Newark. A station hostess is on duty to take care of passengers while waiting for planes.

Right: Passengers out of Boston on American Airways' planes depart from this convenient terminal office. Note the location of baggage scales adjacent to ticket desk. Agent can read weights directly from the large dial.

**Engineers and operators would like to know**

# How much is lightness worth?

*By Edward P Warner*

*Editor of* AVIATION

HOW MUCH is lightness worth? The question is one upon which many engineers have formed their own opinions. Their conclusions range in written expression from the epigrammatic observation of Major Green, of the British Armstrong-Siddeley Company, that he would "spend a pound to save a pound any time," to an estimate of $40 per pound offered by a well-known American metallurgist. We are going in search of a definite answer, with arithmetic taking the place of speculation.

The particular objective is fixed upon the determination of the permissible degree of refinement in an airplane structure or power-plant. Suppose that beryllium costs $50 per pound, and that its strength is such that 1 lb. of that material will replace 1½ lb. of duralumin, costing a total of 90 cents. Neglecting labor differences, $49 would have been paid out to save ½ lb. of weight. Is it worth while? Suppose, again, that, by more careful fabrication and more frequent changing of gages along the length of the longerons, 5 lb. could be taken out of the weight of a steel-tube fuselage with an addition of $25 to labor cost. Again, would it be worth while? To every such question there is a definite answer, and nothing more elaborate than simple arithmetic, starting from a knowledge of the basic facts and of the unit costs involved, is needed to provide it.

Certain assumptions must be accepted as a preliminary to such an analysis. It must be assumed, for instance, that there is an infinite range of power plants available, and that one exactly fitted to the conditions of the problem will always be selected. Actually, of course, if a weight saving makes it possible to reduce the engine output by 2.4 hp., instead of adopting a new engine with that much less power the user of the plane will either increase the cruising speed slightly or cruise at a fractionally lower proportion of the rated power-output. Nevertheless the assumption is fair, for it correctly represents the general average effect, and when the changes of required power are substantial it actually does become possible to shift over to an engine of lower power than the one used with the original, and heavier, structure.

As a measure of arithmetical convenience, unit weight savings will be assumed in the computations, and as a result the changes in power and in costs will appear exceedingly small; but in practice any definite refinement introduced into construction, at a definitely recognizable increase of cost, is likely to save considerably more than a single pound and the derived figures will be multiplied correspondingly.

In approaching the problem, two alternative assumptions upon the disposition to be made of the weight saved, so distinct that they have to be treated as separate cases, are available. If a pound be saved in the structure or the engine, that reduction can either be used to permit a general decrease in the size of the airplane, scaling down the engine power, the wing area and the weight of the remaining structure all in the same ratio, or the power and dimensions may be kept unchanged and the pound so saved may be considered as directly added to the permissible pay load. Palpably the first hypothesis is the more reasonable, and it will be used for our first calculations.

After this somewhat lengthy introduction we come to grips with the statistical raw material. In a general way, in setting up formulas for cost and performance, I have followed the forms developed and applied in a paper analyzing the relation between speed and operating cost in air transport which I presented to a meeting of the Society of Automotive Engineers three years ago [abstracted in AVIATION, August 31, 1929]. The formulas have, of course, been modified where necessary to allow for progress in design since 1929, but their general form remains much as of old. They have not been very severely criticized by anyone other than their author, and there is a certain advantage in maintaining consistency between the two papers.

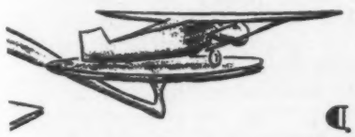
### *Cost of equipment*

The first step is to find approximations for unit costs in terms of power and weight,—formulas representative of current market prices and operating experience. Thus, for example, I take the cost of a power plant and its accessories as $16P$, that of the airplane structure as $8P + 1.2W$, where $P$ is the rated engine-power and $W$ is the gross weight ready for flight, including load. The formulas give the list price correct to within 20 per cent for most typical present-day commercial planes, and there are about as many errors in one direction as in the other. The cost of fuel and oil is taken at 2.1 cents per horsepower-hour, which is about the correct average for the United States as a whole (based on gasoline at 18 cents a gallon).

Insurance on the plane, including crash coverage, is rated at 12 per cent of the current value of plane and engine, or an average throughout the machine's life of 8 per cent of the first cost. Interest on investment is set at 8 per cent, aeronautical enterprises still rating as unseasoned and demanding a commensurately high return. Depreciation is taken as 23 per cent annually on the airplane and 42 per cent on the power plant, corresponding to a life of 4 years for the airplane structure and 2¼ years for the engines, with an assumed flying time of 1,000 hours per year. (And allowing for the accumulation of interest on a depreciation reserve. Without such allowance, the annual increment based on a four-year life would have to be 25 per cent instead of 23.) Other figures of a similar order will be introduced as the need arises.

As the basis for all calculation, 1 lb. is

assumed to be eliminated from the empty weight of the plane, saved either in the structure or in the engine and without modification of overall dimensions or power. The elimination, resulting either from better and closer design, better and more elaborate construction, or the use of more efficient materials, has certain obvious consequences. The most immediate are possible reductions of wing area and of power, assuming that the performance and therefore the unit loadings are to be kept constant. Equally plain is the resultant reduction in loading on those parts of the structure which were not directly and primarily affected,



permitting a decrease in the cross-sectional areas and weights of their members, of course presuming that factors of safety are to remain undisturbed. If the weight be saved in the fuselage, for example, the load to be carried by the wings in flight is proportionately reduced, and the dimensions and weights of the structural members in the wings can be cut down without loss of weight.

**¶ A designer stands before his last year's transport model, looking at it and wondering how he should change it to make it a better ship. Is it more important to reduce the weight of the structure, or to reduce the price? And if the weight is to be reduced by making the structure more complicated or more efficient, how much extra can the customer be expected to pay for it? There has been a lot of guessing upon those questions, but very little real analysis. Mr. Warner has stalked the answer, shot it down with a slide rule, and mounted it upon the printed page.**

In short, the definite saving of 1 lb. in the weight of the airplane has the same final effect on total weight as a reduction of 1 lb. in the payload carried. It permits the saving, due to reduction of dimensions and the other factors just enumerated, of approximately 0.4 lb. additional. The total weight-reduction is not 1 lb., but 1.4. Assuming a power loading of 15 lb. per horsepower, the rated power can then be reduced by 0.09 hp.; and the normal operating-power, assuming the machine to cruise at 60 per cent of full power, by 0.06 hp. The reduction in power-plant cost, using the formula already given, would be $1.50, and in that of the airplane $2.43.

Depreciation, insurance, and interest on investment would aggregate annually, using the data already given, 58 per cent of the initial cost of the power plant and 39 per cent of that of the plane without the engine. The savings on those headings resulting from the initial unit weight-reduction are 87 cents and 95 cents, respectively. Another economy comes from the diminished size of the plane, the reduction in hangar space required, and the saving in personnel needed for handling on the ground. Handling and storage costs for planes housed in the plane-owner's own hangar may be taken at 15 cents per year per pound of gross weight, as a fair average. Upon that score a saving of 21 cents can be marked up to correspond to the total weight-decrease of 1.4 lb.

### *Maintenance charges*

The saving in cost of fuel and oil, dependent on the reduction of cruising power, amounts to 0.125 cents per hour, or, assuming 1,000 hours of flying per year, $1.25 per year. Maintenance expense on the engine is assumed to average 0.55 cents per rated horsepower per hour for the engines now in service, but to vary with small changes in power only one-half that rapidly, since the amount of shop labor is but little affected by changes in size. This is equivalent to a declaration that maintenance costs vary as the square root of engine power, or that they are 17 per cent higher, for example, on an engine the size of the Hornet than on one the size of the Wasp,—other things being equal. The assumptions are in good accord with general operating experience.

The saving on that item is then 0.28x 0.09, or 0.025 cents per hour, or 25 cents per year. Maintenance of the plane is assumed, with present experience as a basis, at 0.08 cents per hour per pound of gross weight. In that instance maintenance labor is more directly affected by weight, and total maintenance cost will be taken as varying, for small changes, three-quarters as rapidly as does the weight itself. The aggregate figure is then 0.08x1.4x0.75, or 0.084 cents per hour, equivalent to 84 cents per year. The total saving is then:

| | |
|---|---|
| Depreciation, insurance, and interest of plane. | 0.95 |
| Depreciation, insurance and interest of engine. | 0.87 |
| Handling and storage | 0.21 |
| Fuel and oil | 1.25 |
| Maintenance of plane | 0.84 |
| Maintenance of engine | 0.25 |
| Total, per year | 4.37 |

Against that must be offset the increases of annual cost resulting from the increase of initial cost incurred in the quest for weight reduction, and at this point it becomes necessary to recognize a distinction, due to the different assumed rates of depreciation, between the effect of weight-saving in the engine and in the airplane structure.

Considering the engine first, obviously depreciation, insurance, and fixed charges are directly proportional to total cost. As already indicated, they can be set at 58 per cent of the initial cost each year. For the airplane, 39 per cent corresponds. It is also apparent that maintenance costs vary with first cost, but not in direct proportion. Labor being affected very little if at all, the direct increase applies only to that part of maintenance expense chargeable to material replacements. So flat a statement should perhaps be slightly modified, for, in general, the effect of weight-saving measures is to increase the complication of the structure and so to increase the amount of work required in stripping or overhauling it. Taking those things into account, maintenance outlay can be assumed to vary one-half as rapidly as first cost, both for plane and for engine, if first cost be changed without change of gross weight or power (the effect of the weight and power changes on maintenance having, of course, already been separately allowed for). Both for plane and for engine, maintenance cost runs about 0.04 per cent of first cost per hour, and may therefore be taken as increased by 0.02 per cent of any increase of cost arbitrarily introduced. For 1,000 hours that amounts to 20 per cent per year, making a total increase of annual cost of 78 per cent of any increase in first cost of the engine, with 59 per cent as the corresponding figure for the plane structure.

Manifestly, the maximum permissible price to be paid for weight-saving is that which will make the increase in annual cost due to more expensive construction just balance the decrease due to reduction of weight. The value of a 1 lb. reduction in engine weight, upon the assumptions used, is then $\frac{4.37}{.68}$, or $6.40. For the airplane structure the corresponding figure is $\frac{4.37}{.49}$, or $8.90. There at last emerges the single figure sought throughout all this tortuous analysis.

### *Another method*

The method just used is, on the whole, the most rational one available, and leads to the fairest answer. There is, however, as already noted on page 382, another method. It is sometimes advocated, and it ought to be included for purposes of comparison.

It may be assumed that any saving of weight in the structure, instead of being used to decrease the size of the ship and the power, is used to increase the payload. Again, as before, we may take a saving of 1 lb. rather than of one passenger as basic, simply as a measure of convenience in calculating unit coefficients. The final results would be the same in any case.

Obviously the extra payload capacity cannot be considered as being effective at all times. It comes into play only when the ship would normally have been filled up for the flight, and when it would have been necessary to decline any further load. In a typical case it may be assumed that that happens about one-third of the time, or, in other words, that on about one-third of all airline trips more payload could be had if there were a little more capacity for carrying it.

In this case the increased costs resulting from the more expensive construction of the ship, undertaken in order to save weight, are, again, insurance on the craft, depreciation, and interest. There must be added also the increased liability insurance on the larger payload capacity. On the other hand, operating costs are decreased somewhat during that large proportion of the total time when a full payload is not being carried, as the gross weight is then decreased by the 1 lb. which has been taken off the structure. The engine can be run at correspondingly lower revolutions per minute for a given speed, and maintenance and fuel costs can be reduced. This last factor, however, is so small as to be almost negligible, for the engine power required for flight of cruising speed varies but very little with gross weight in modern transport airplanes.

At the same time, the income of the operation is being increased by adding an extra pound of payload on about one-third of the total number of flights. Again allowing that the plane flies one thousand hours or 120,000 miles per year, and that income is received at the rate of 60 cents per ton mile, the added income in a year for a saving of 1 lb. in structure and a like increase in payload capacity should be $12. At the same time the increase of total operating cost in each year would be, as already indicated, 49 per cent of any increase in first cost due to refinement in structure and saving of weight, plus the liability insurance on the increased load, which, if all the load were in passenger form, would be at the rate of approximately $1 per pound of payload per year, or $200 per passenger seat. Without repeating all the steps of a more or less obvious arithmetical operation, it is easy to see that the unit value of weight saving on this method of calculation comes to $22.40, or about three times as much as already suggested. For an equal saving in power-plant weight, the figure would be $16.20.

The first of the methods used seems much the more reliable of the two, as the second makes the answer depend so much upon traffic conditions, and also because in many cases the operator who finds that he has some extra payload available will be able to run an extra ship to handle it, instead of merely wishing that he could get the payload into his existing equipment. However, both methods have some merit, and taking both into account it seems fair to set the average overall value of weight saving under present conditions at around $8 per pound for the engine and $11 per pound for the airplane structure.

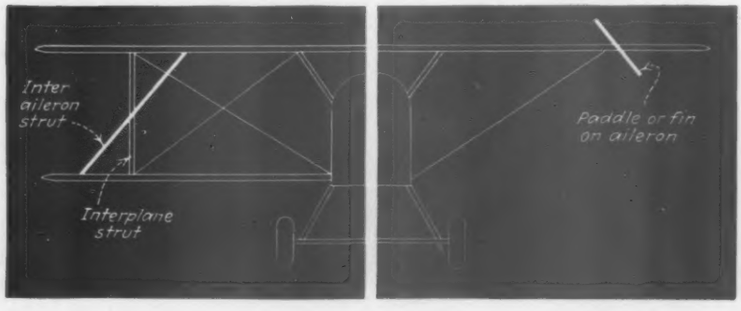
A word of caution is of course necessary. As is obvious from the method of derivation, these results apply only to transport planes, large or small, operated with some regularity by companies which are in a position to raise any amount of money necessary to meet the first cost of equipment by going into the open market and paying the necessary price for it. They have nothing to do with the problem of the design of planes for private owners or for operation by small corporations on their own business, for there the element of first cost plays a leading part. It is futile to tell a prospective purchaser that paying out an extra thousand dollars in the first place will be more economical in the long run if he hasn't the thousand dollars and has no way of getting it. Only the regular operator can afford to be both cold-blooded and far-sighted in his analyses, and then to follow the results wherever they may lead.

The results of this particular analysis have left us well within the rather wide range covered by speculation and estimate in the past. Nevertheless, whatever the magnitude of the figures that individual engineers may have set up as representing their own guesses at value of weight-saving, few of them, especially among commercial builders in the United States, have had the courage of their convictions or been prepared to shape their courses in accordance with their own estimates. The same criticism holds for the operators. Take as an example an airplane weighing full-loaded, some 13,000 lb. and selling, complete with power-plants, for $50,000. Suppose that, by use of every possible refinement in design, the weight of the structure were reduced by 700 lb., with the ultimate result of cutting down the total power by 70 hp., the gross weight by 1,000 lb., and the wing span by 3 ft. Suppose the performance and payload to remain unchanged, and the price to be raised to $54,000. I doubt if the change would be a very popular one among purchasers, or if manufacturers would feel justified in risking it, yet the machine would be a better bargain, and have a better chance of paying for itself in transport service, than before. The disposition of many transport operators, here and abroad, has been to keep their eyes fixed much too firmly upon first cost.

# The Dichman effect

ONE of the most difficult things to acquire in learning to fly is the proper co-ordination of rudder and aileron so that neither skids nor slips occur in any light maneuver unless by the pilot's intent. In cases where an airplane goes out of control under bad flying conditions, it is usually due to lack of proper co-ordination in the use of the controls. Even the most skillful pilot with the finest instruments available finds that his time is fully occupied in maintaining the equilibrium of his airplane when flying under blind conditions. He has little time available to devote to navigation and communication. It is apparent, therefore, that any practical method of relieving the pilot of a part of the manual effort and attention necessary to maintain equilibrium alone will reduce blind flying hazards.

Automatic piloting devices have been developed to overcome these difficulties, but at best they are mechanically complicated, expensive, and add considerable to the weight of the airplane. A simple self-operating lateral control has been developed by E. W. Dichman, now of the Vought Company, while on duty at Wright Field. The effect is obtained by the use of a very simple mechanical arrangement which makes it



possible to utilize the forces of side slip to stop the slip almost before it starts. One simple method of accomplishing this result in a biplane having ailerons mounted on both upper and lower wings is to attach the inter-aileron connecting strut so that it makes an angle of about 45 deg. with the vertical, with the top end nearer to the plane of symmetry of the airplane. On monoplanes, or planes having ailerons in one wing only, the Dichman effect may be obtained by mounting a small paddle-like fin to the aileron, the plane of the fin lying parallel to the direction of normal motion of the airplane, making an angle of about 45 deg. with the plane of symmetry.

On skidding or slipping the air forces strike the side of the strut or paddle and, due to the angularity, exert a downward component which serves to depress the aileron, thereby raising the wing sufficiently to stop the lateral motion. Once the motion has been stopped the forces cease to act and the aileron returns to neutral. The sensitiveness and effectiveness of the device are dependent upon the flat plate areas exposed which may easily be modified to suit any particular design. For example, it has been shown by experiment that an inclined inter-aileron strut width of 4½ in. produces the most desirable effect on a Douglas observation.

The reaction is almost instantaneous, beginning before any lateral motion is apparent to the pilot. It has been shown that with a properly equipped airplane possessing normal longitudinal stability, it is possible to fly indefinitely through rough air without touching the stick, maintaining the proper compass course by means of the rudder. Thus in very bad weather a pilot may fly by rudder only, leaving his hands and a greater part of his attention free to devote to navigation and his radio. The device in no sense takes away the control from the pilot, however, for he can at any time move the controls at will to produce side-slip, skid or any other maneuver. The only effect in such cases is a gentle, though definite pressure on the stick against the pilot's movement.

# Advice to the tired business man

**¶ In an attempt to break down the resistance of business men who are calloused to high pressure salesmanship, the Monocoupe Corporation has published and distributed a booklet, the introductory portion of which is reprinted herewith. Intended to force the prospect into a frame of mind in which he will sell himself, it makes a very interesting approach to the potential private flier.**

SOME TIME ago I read a story about a small town minister who lived very happily in his smug but picayunish conception of God, heaven and the importance of humans until he made a visit to an observatory. Here the magnitude of the scheme of things violently obsoleted in a few hours a philosophy that had taken a lifetime to acquire. Transitions in a viewpoint can be too abrupt. He developed an acute inferiority complex; erstwhile matters of importance assumed insignificance. He was left bewildered and miserable.

This may be a rather far-fetched parallel but bears certain relation to the suggestion that you think well before having anything to do with flying. You will find that flying will change your entire philosophy of living. It is an exacting master, equally as compelling as the habit of drugs. It is insidious in the way it creeps up on one, attacking human senses and emotions that you now have and drawing out dormant ones inherited from heartier forbears of robust days when living was more stern.

To begin with one must avoid having a feeling of superiority mistaken for arrogance. Until one flies, one does not know what the splendor of nature really is. You can hardly help but feel the utmost pity for the rest of the poor, crawling things that grovel in their own muck and never get to see anything. Perhaps once in their lives they go to Grand Canyon to view one panorama and talk about this one picture the rest of their lives. If you fly, you must not let them suspect that you pity them or they will hate you for it and this will not help your business.

Your nomadic tendencies creep out frequently enough now, despite several thousand years of restraint. The unhampered freedom of flying, the dearth of detours and infinite number of destinations in a single day by the mere kicking of a rudder permits the growth of gypsy tendencies which you will humor entirely too often for the good of your business. The fact that you can dictate your mail this morning almost any place east of the Mississippi, keep an appointment tonight in New York, play golf tomorrow morning in Carolina and see a horse race in Kentucky in the afternoon will become an imp of temptation, helping you form logical excuses for being in various or similar places on the most flimsy pretexts of business.

Your first impulses are the exhilaration of speed, the romance of the Magic Carpet, the element of danger which becomes high adventure — the very basic thing that led your kin to conquer the West, your friends to the Arctic, big game hunting in Africa—the element of danger that is the basis for millions drinking "Bootleg."

Later on as you become more accustomed to the idea, you develop certain rhythmic pulsations that you feel in music—an escape from all established, mundane things — a new and glorious freedom—all of which is bad for you, for as a participant in this great, complex scheme of commerce and business, you have no right to attempt any respite from the tedium of the days.

Don't be misled in the belief that flying is invigorating, other than to the uninitiated. As your taste develops it goes beyond that, and its sheer grandeur creates extreme emotional fatigue.

Your friends and associates will want to talk about flying in terms of economical, fast transportation—a piece of business equipment. One can't permit that —it's like being married for business reasons. They will want to admonish you about the danger. For a time you will religiously defend the safey of flying by reciting the millions of miles flown per accident, etc., etc.—but they will keep at it and at it until you tire of the discussion and finally shock them by confessing that you take so much more out of life that it doesn't matter, that there is an irresistible allure to a little danger, that longevity isn't everything—an alligator lives 500 years but sleeps 450 of it. Such a philosophy is not reconcilable with our highly developed state of commercial peonage.

Other people will attempt to flatter you by calling you aggressive, farsighted, a leader, for putting your signature to aviation. At the best it is a fad! If we still drove horses there would be a market for our surplus grain. Automobiles are an economic waste. People drive them places without an economic reason for getting there. Automobiles turned out to be a fad after all, and yet there were irresponsible people who flattered you with silly talk about being aggressive when you bought an early automobile.

This business of motoring through the air, playing tag with clouds, merely creates an envy for your new escape from dull care. Your friends and acquantances suffer violent astonishment —they suggest that you have gone haywire—and soon they are left to the routine of their golf and contract without you.

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# EDITORIALS

AVIATION

EDWARD P. WARNER, *Editor*

## Mr. Glover sounds a keynote

ON JULY 20, the Second Assistant Postmaster General addressed the members of the Air Transport Section of the Aeronautical Chamber of Commerce. The date ought to be historic.

June, in presidential election years, is conventionally the keynoting season. Senators Dickinson and Barkley adhered to tradition. Mr. Glover was a month late by the political calendar, but to the aeronautical industry his utterances were much more important than anything that had been said in the Chicago Coliseum during the previous month.

He announced a new doctrine. The efforts of the aeronautical industry have been dispersed in a dozen different directions. There has been manufacture for military purposes, and for private ownership, and for industrial sales. There are a dozen different kinds of operation of airplanes. There are flying schools, and there is aerial survey. Mr. Glover has proclaimed the fundamental truth that all of them are bound up with air transport, and that the hope of every aeronautical activity for its own success in future lies through air transport promotion. The entire industry, whatever else it may be doing, must throw itself behind air transport with its whole weight. The entire industry, responding to Mr. Glover's call, must set itself about a campaign for air transport development and for traffic promotion such as the Accessories Section of the Chamber, under the leadership of Mr. S. L. Gabel, undertook three years ago.

Other lines of activity will continue to be important, but this one has unique possibilities. We are a commercial nation. We find it easy to visualize the benefits of air commerce, and to understand that every individual can share for himself in those benefits. Air transport, while its progress helps to strengthen all branches of aeronautical enterprise, is gaining strength in itself even more rapidly. Taking the aeronautical world as a whole, military business has been the backlog up to the present time. Until very recently, in fact, it was not only the backlog but the whole conflagration. It remains a matter of very potent concern to the manufacturer, but it is gradually being displaced from its supreme position. In 1925, the manufacture of military airplanes and engines represented about 80 per cent of the total of all American aeronautical activities in dollar volume. Transport was about 10 per cent. In 1932, military manufacture is down to 35 per cent of the total, and transport operations represent 45. Transport's is the rising star.

Not only must the entire aeronautical world get behind the transport lines. It is even more important, as Mr. Glover pointed out with great force, that the transport lines must get behind each other. The airlines are not pre-eminently competing with each other, nor even with the railroads and other transport enterprises, but with the vast force of public inertia. The greatest threat to the prosperity of the XYZ airline is not the man who flies on the ABC airline, but the man who doesn't fly at all. The first undertaking is to get him, and all his relatives and friends, into the air. And that is a job upon which everyone must pull together. "TO HELP OTHERS IS TO HELP OURSELVES," says Mr. Glover, and he says it loudly enough so that there can be no misunderstanding. It is with considerable satisfaction that we on AVIATION recall that we have persistently advocated mutual aid and support, and that no less than four of the planks in the transport section of AVIATION's Platform of last winter bore upon the necessity of improved co-operation.

It is pleasant to be able to report that progress is being made. The transport operators are drawing steadily closer together. The recent announcement of the General Air Express System is a symptom. Mr. Glover's exhortation ought to speed the process.

This is a singularly appropriate time at which to sound the note of air transport's importance to the rest of the aircraft industry. After three years of general business depression, there are signs that the light is about to break through. This is the time for business to prepare for increased markets and increased demands. This is the time to take advantage of the deliberate efforts that the Federal Government has made to loosen credit and to provide funds for any

reasonable business activity. Half the transport planes on American lines are approaching, or have actually reached, the point of obsolescence on economic grounds. At least 250 new transport machines ought to be purchased for delivery within the next eighteen months. The time is ripe for the manufacturers of planes and the transport operators to get together and develop a plan for building and putting into service some $7,000,000 worth of airplanes. Six months ago it might have been futile to discuss anything of the sort, because of shortages of cash and the impossibility of new financing. Today the banks are, or almost certainly very soon will be, in a position to carry the load of financing and to carry it on long and easy terms. Mr. Glover's speech fired the starting pistol for a newly aggressive campaign to get the best and most modern equipment, to operate it in the most efficient fashion possible, and to go out and find increased traffic to fill it. From this moment, there is no place for laggards or doubters.

## Soaring turns a new leaf

THE "glider movement" in America has entered a new phase. The meet held at Elmira in mid-July under the auspices of the Soaring Society of America marked the transition from an activity predominantly commercial to one predominantly sporting and scientific. A year ago there was more than a little uncertainty over the possibility of keeping organized gliding alive, for it had had to exist upon support from the airplane industry and the airplane industry had no more support to give. Glider development had been conceived in terms of tens of thousands of gliders built, and hundreds of thousands of boys trained to fly them and later to buy powered planes, and the dream had failed to come true.

There was nothing in the way of a dream about this year's meet. It was a very solid affair—economically and conservatively run. It ought to insure the survival of gliding as a sport in the United States.

A few of the statistics are too impressive to be omitted. Forty-five soaring pilots were on hand, including 30 new ones who qualified during the meet. One hundred and fifty-three soaring flights were made, nineteen of them going across country for considerable distances, and the total time in the air was almost 200 hours.

German and American experience are in agreement in showing that soaring flight needs five things if it is to live and grow in strength. It needs: (1) intelligent management; (2) proper scientific direction by competent meteorologists and aeronautical engineers; (3) the participation of men who deal with gliding only as a sport, and who have no ambition to gain any personal financial advantage from their connection with it; (4) an intelligent commercial interest, animated by a real love for soaring flight and organized on a moderate scale for the production of gliders and the operation of schools for training pilots; (5) the enthusiasm of youth. It does not need: (1) huge financial grants; (2) great amounts of indiscriminate publicity in the sensational press; (3) "showmanship" of the type that would make the glider an incidental attraction at county fairs; (4) hare-brained stunts.

The Elmira contest met all the specifications. Among the competitors there were such solid members of the community, with no desire to take anything out of the glider but enjoyment and perfectly willing to spend their own money for that purpose, as the president of a nationally-known manufacturing company, a member of the New York judiciary, and a United States Naval Constructor. Among the competitors, also, were groups of young men whose enthusiasm had led them to surmount every sort of economic obstacle and to fight their way to Elmira and live there under conditions almost as difficult as existed in Germany at the Wasserkuppe ten years ago. The sort of leadership that Mr. Lawrence has given to interested boys in Providence, for example, ought to be duplicated just as sensibly, and with just as little expenditure and fanfare, in 50 other communities.

Apart from the excellent quality of the entry, two things particularly stand out on the Elmira record. First, it was the first glider competition in America to be organized on really scientific lines. The presence of Dr. Lange of the Massachusetts Institute of Technology, and the availability of a plane for daily flights of atmospheric exploration, provided meteorological data far superior to any that could be secured in previous years. The sensational long-distance flights that were made were due even more to Dr. Lange's efforts than to the skill of the pilots or the quality of their soaring machines. For the first time, American soaring began to approach a parity with the German standards.

The second notable feature, in happy contrast with the dismal history of the 1931 meet, was the total absence of serious accidents. No doubt many factors played a part in making that possible, but the work of the officials was the most important. It is hard to single out a few names, where so many men worked loyally for the good results, but particular credit should go to Warren Eaton, president of the Soaring Society of America, to Earl Southee, to Sherman P. Voorhees, to Charles H. Gale, and to the Elmira business men who supported the meet. Their efforts and those of their co-workers and of the competitors did more than insure a technical success. They created a friendly local atmosphere; they gave the people of Elmira something to be proud of, and they enabled that part of the aeronautical community which finds itself incur-

ably interested in gliding to feel some assurance that they can look forward to a continuance of the sport on sound lines.

## Taps for a pioneer

THIS is the month in which to go to a library and to read an aeronautical book of 25 years ago. If you have never turned the pages of "My Airships" you have a real delight in store for you. If your aeronautical experiences date back far enough for you to have read the volume already, you ought to read it again. Its author, Alberto Santos-Dumont, just died at his home in Brazil, and his passing recalls a long succession of memorable aeronautical episodes of which he was the central figure.

Santos-Dumont's contributions to aeronautical science may not loom very large after this lapse of time, but no man ever displayed more enthusiasm for his studies. Invention was a sport and a magnificent adventure. He never had to think of it in commercial terms, and when aviation began to develop an industry his interest vanished. His was the Latin temperament at its absolute best, and even now one can hardly read the record of his work without feeling the excitement that every new experiment aroused in him.

Santos-Dumont came from Brazil to Paris as a young man, filled with a consuming passion for whatever was new. He started racing motor tricycles when 25 miles an hour was a creditable racing speed. From tricycles he turned to balloons, from balloons to airships, of which he built a dozen, and from airships to airplanes. After innumerable hair-breadth escapes he had succeeded in 1902 in driving one of his airships a distance of 9 miles and around the Eiffel Tower. In 1906, standing at the controls of an odd-looking box-kite that flew tail-first and clearing the ground for some 500 ft., he became the first person in Europe to fly an airplane and the first in the world to make a take-off and landing from a wheeled landing gear.

Santos always dealt in miniatures. He weighed barely a hundred pounds, and he had no sooner qualified as a balloon pilot than he built himself a spherical which probably still holds the record for smallness of size. Scarcely 20 ft. in diameter, it carried a basket barely large enough for the pilot to stand in. Tiring of that, he constructed an airship almost as tiny. The sight of Santos touring along a hundred feet above the Grand Boulevards became a familiar one at a time when automobiles were still rarities, and he had a large part in creating an enthusiasm for aeronautics among the French people that lasted for ten years and accounted for a deal of progress. As a focus for national interest and a personal symbol of a new art, Alberto Santos-Dumont was the Lindbergh of his day.

Still later, as his last important aeronautical activity, Santos-Dumont built the famous Demoiselle monoplane. Like his smallest airship, it was fitted to his own dimensions, and very few monoplanes of smaller span have been flown in the twenty years since the Demoiselle disappeared.

He was an interesting person. Everything that he did was interesting. History will not be able to overlook him.

## Ohio simplifies avigation

THE unhappy pilot who found himself lost over strange towns has been the beneficiary of a great amount of conversation in the last few years, but singularly little has actually been *done* in his behalf. Great propagandas have been organized for getting towns air-marked, and most of them have petered out after having used a half a barrel of yellow paint on identifying a couple of dozen roofs,—or less. State Legislatures have wrestled with the subject and have passed resolutions decorously adjuring towns and cities within their borders to do something about marking themselves for the air traveler. It has been left for Ohio, however, to stop being decorous and to say to the local sub-divisions of government: "Dammit, you *must* act!"

The Ohio State Legislature, under the spur of the late Frank McKee and his successor Fred Smith and other enthusiasts, passed a law some two years ago that made air-marking as definite an obligation upon the government of every community as the maintenance of public order or the protection of public health. The result is that 600 communities have already been air-marked, almost all of them in the past year, and some of them at several points. The number of delinquent towns is being rapidly reduced, and Ohio ought to be qualifying as an air navigator's paradise.

This is a development at which no one need look in silent envy. Practically all of the other States have exactly the same powers as Ohio to deal with the communities which derive their very life from the State and to enforce reasonable obligations upon them. It is only necessary to convince 47 other Legislatures as that of Ohio was convinced. To the towns and cities, the expense and time involved are almost trifling. To the owner of an airplane, the matter is a vital one. Instead of engaging in further spasmodic voluntary paint-the-roof-top campaigns, it would be well for N.A.A. chapters and Chambers of Commerce aviation committees, and service clubs, and all other interested bodies, to get together behind their Legislatures and give a long, strong push towards the goal that Ohio has already reached.

# NEWS OF THE MONTH

### *Von Gronau does it again*

THE Island of Sylt, one of the North Frisian group off the north coast of Germany, saw the take-off of Captain Wolfgang von Gronau on his third annual transatlantic flight on July 22. His Dornier Wal flying boat, D-2053, and radio operator Albrecht were veterans of the previous North Atlantic crossing. Mechanic Hack had made the trip in both 1930 and 1931, but it was all new to 25-year old co-pilot von Roth. Captain von Gronau's current flight, which like his previous expeditions for meteorological research and survey included landings in Iceland, Greenland, and Laborador, will not terminate at Chicago. The Groenland Wal is scheduled to continue at a leisurely pace to the Pacific Coast, and perhaps thence via Alaska and the Aleutian Islands to Japan.

The air mail route being investigated by Captain von Gronau would be direct from Europe to the Pacific Coast, instead of to New York, where express steamer service offers strong competition. Planes catapulted from the North German Lloyd Company express steamships (the Europa carries a Hornet-powered Junkers; the Bremen a Hornet-powered Heinkel) from as far as 1,500 miles out of port under ideal weather conditions, already effect a saving of as much as three full days in final delivery, carrying air mail from London to the Pacific Coast in five days. Canadian Pacific steamers from England to the Strait of Belle Isle and air transport from there to Montreal and Washington bring mail from the British to the American capitol in the same time.

Removing the kinks from the airway between Richmond and Jacksonville has resulted in reduced rates on Eastern Air Transport. Along the shortened coastal route fare cuts of from a few cents to three dollars have been made. Other rate decreases are the result of a new policy of allowing round trip reductions between all points two hundred or more miles apart, instead of 500 miles as formerly. United Air Lines also has reduced the rates on its Chicago-Dallas route 10 to 15 per cent, bringing them down to rail-plus-pullman fare.

### *Night flying grows*

On Aug. 1 United Air Lines commenced operation of the first all-air night passenger service between New York and Chicago. The Midnight Flyer leaves New York at 10:15 p.m., reaching Chicago at 5:12 a.m., while midnight departure from Chicago brings the eastbound plane to New York at 8:06 a.m. Daily passenger schedules between New York and the convention city now number five, the 27-hour, coast-to-coast services two in each direction.

Night air mail service is now operated on the Western Air Express contract route between Salt Lake City and Los Angeles and San Diego, in accordance with the action of Congress providing funds for that specific purpose. The plane leaving Salt Lake City at midnight reaches the California cities in time for the morning delivery. Returning at the close of the business day it connects at Salt Lake with a plane going north into Montana, as well as with the eastbound continental route.

### *Mr. Glover suggests*

Meeting with the executive and air transport committees of the Aeronautical Chamber of Commerce to consider the future development of air mail and passenger traffic, W. Irving Glover, Second Assistant Postmaster General, presented suggestions for a new national aviation policy. For exclusive concentration upon the development of their own branches of the industry Mr. Glover would have the military, commercial, industrial and governmental interests substitute a unified policy of educating the public to the use of air transport, upon the success of which the other branches ultimately depend. He saw an effective means of national defense and a definite contribution to the return of general business prosperity resulting from such a concentration of interest.

Postal Telegraph, which handles ticket sales for practically all the major airlines, has opened a central air ticket office in its offices at 46th Street and Fifth Avenue, New York City, where special agents are on duty to furnish prospective air travelers with information and itineraries. Contingent upon the success of this office will be the establishment of a similar central air ticket office in every large city served by airlines.

Increases in passenger traffic between London and Paris to almost twice the levels of 1931 have led to the establishment by Imperial Airways of a new terminus in Paris. The arrival and departure point is six minutes nearer to the airport of the Bourget, and outside the area of heavy traffic. The old office on the Avenue de l'Opera will be retained as a booking office and information bureau.

American Airways on Aug. 6 inaugurated its air mail and passenger service between Boston, Providence and New York. No change is made in the departure times from Boston and New York, but four of the eight planes scheduled daily from each city stop at Providence, linking it with the transcontinental air network, while the other four fly the old route by way of Hartford. Providence is less than two hours flying time from New York, and only slightly more than half an hour from Boston.

### *Cup races head the bill*

Air racing holds the center of the summer stage as usual in European aeronautics. The eleventh annual handicap race for the King's Cup, flown from Brooklands airdome, this year had a unique setting of perfect weather over a course of 1,233 miles. In a Fox Moth limousine biplane powered with a new Gypsy III engine, Lawrence Hope led the field from start to finish, winning the cup for the third time. His average speed was 124.13 m.p.h. almost ten miles an hour more than the estimate of the handicappers. Second to cross the line was a tiny single-seater Comper Swift monoplane, entered by the Prince of Wales and flown by Flight Lieut. E. H. Fielden, his personal pilot. An amateur pilot, W. L. Runciman, came in third to win the Siddeley trophy awarded to the first member of a flying

## Calendar

| | |
|---|---|
| Aug. 27-Sept. 5 | National Air Races, Cleveland. |
| Aug. 30-31 | Annual Aeronautic Engineering Meeting of the S.A.E. at the National Air Races, Cleveland. |
| Sept. 11-12 | National Exchange Club Air Show, Syracuse, N. Y. |
| Sept. 25 or Oct. 8 | Gordon Bennett Balloon Race, Basle, Switzerland. |
| Oct. 8-23 | Aviation Exhibit, 46th Annual State Fair of Texas, Dallas. |
| Nov. 18-Dec. 4 | Thirteenth International Aeronautical Exhibition. Grand Palais, Paris. |

club to finish. A new record for the fastest time in a King's Cup race was set at 175.9 miles per hour by the scratch machine, a Jaguar-powered Avro mailplane, which left on its last 238-mile lap after the winning plane had crossed the finish line.

Veteran record holder also is Marcel Haegelen, chief pilot of the Societe Generale Aeronautique, who carried off the Michelin cup this year as well as in 1931. Flying the Hanriot-41 low-wing monoplane equipped with a 230-hp. Lorraine engine in which he won the 1931 event, Haegelen made the 635-mile circuit from Toulouse in 10 hours and 20 minutes. Allowing for specified landings at fifteen cities en route, his actual flying speed is computed at about 170 miles per hour. The Michelin cup was offered for the first time in 1928 by the Michelin Company and is open to planes of all nations, provided only that they are equipped with engines of less than 230 hp.

Sixty-seven planes have entered the International Reliability Air Tour, the light plane contest organized by the German Aero Club. Although German planes will predominate, 35 entrants from France, Italy, Czechoslovakia, Poland, Switzerland, and Great Britain will make the 5,000-mile tour, leaving Aug. 11, to surmount such hazards as a crossing of the Alps between Cannes and Lyon and an overwater stretch from Copenhagen to Gothenburg.

As finale to the summer's events will come the Gordon Bennett International Balloon Race, starting from Basle, Switzerland, on Sept. 23. American entrants will be the balloon of Ward T. Van Orman of Goodyear, last winner of the International trophy, a U. S. Army balloon piloted by Lieut. W. J. Paul, winner of the 1932 National Balloon Races, and a Navy balloon piloted by Lieut. Comdr. T. G. W. Settle, who won the National Race at Akron in 1931.

### *All roads lead to Cleveland*

Cross-country races from many points to the United States will converge at Cleveland on Aug. 27 to inaugurate the outstanding event of the American racing season. Amateur air pilots will take off from Washington in competition for the Charles Lanier Lawrance trophy. Also from Washington will start the Eastern Division of the handicap derby for the Cord Cup Race. It will meet the division from the Pacific Coast at Bartlesville, Oklahoma, and proceed thence as a single event. Joined, they are likely to comprise the largest mass competitive flight in the history of aviation.

The Bendix trophy will be flown, as last year, from Los Angeles to Cleveland. Another handicap derby, planned primarily for sportsman pilots, will be flown from Roosevelt Field for the new trophy offered by William B. Leeds. Both men and women pilots, flying any A.T.C. or group-2 ship, are eligible to enter.

Something entirely new on the flight program of private owners is the good-will flight to be made from Roosevelt Field to St. Hubert's Airport in Montreal to witness the fourth annual Canadian Air Pageant. From 30 to 60 planes plan to make the flight in formation, flying in groups of six, each in command of a flight leader.

### *Sailplanes win more laurels*

"Most successful gliding meet ever conducted in the United States," is the title awarded the 1932 soaring contest by the final report of its referee. A total of 153 soaring flights, made by 45 pilots who were in the air almost 200 hours, exceeded all previous records. Of the major awards, those for duration and distance went to Jack O'Meara, for his flights of 8 hours 18 min. and 66.6 miles respectively. Martin Schempp in a flight to 5,270 ft. took the altitude award, but is ineligible to claim the American altitude record set at 3,304 ft. by Lieut. W. A. Cocke because he is a German citizen. A new glider world speed record for a closed circuit over a one-kilometer course was probably set at 38.7 miles per hour by 17-year old Walter Snell. Authentication from the F.A.I. is necessary to make it official.

From the Wasserkuppe comes the report that 56 gliders, two of which were from the Polish Aero Club, took part in the thirteenth Rhön competition. In 1931 there were 40 entries.

### *On Washington's trail*

From dawn to dusk on July 25, Maj. James H. Doolittle flew his Lockheed Orion monoplane, with Washington's great-great-great-grandniece and a representative of the Aeronautical Chamber of Commerce as passengers, over all the points visited by Washington during his career. General Washington would have needed four years to travel by stagecoach and saddle the 2,610 miles which Major Doolittle covered in 15 hr. and 40 min. To celebrate the 157th anniversary of the Postal Service, thirty packages of letters with air mail stamps were dropped at as many points of historical interest along the route. Though the yellow monoplane did not conclude its flight at Newark, N. J., until 9:15 o'clock in the evening, by ten o'clock the next morning 29 of the 30 letters were in the hands of those to whom they were addressed in New York.

When Amelia Earhart, veteran trans-Atlantic flier, set the wheels of her Wasp-powered Lockheed Vega down on Newark Airport late in July she had bettered the women's solo transcontinental record previously held by Ruth Nichols. A forced landing at Columbus prevented her beating the non-stop record of Capt. Frank Hawks, which had been her objective. Miss Earhart's elapsed time was 19 hr. 15 min. Captain Hawks made the trip in 17 hr. 38 min. in June, 1929.

### *Autogiro supplants band-wagon*

A new rôle for the autogiro is an active part in this year's political campaign on the West Coast. Senator Tallant Tubbs (California) will carry his message of immediate modification of the Volstead Act to smaller towns and inaccessible communities in the same Pitcairn autogiro which made a visit to the White House lawns during the presentation of the Collier Trophy last April.

In the South American continent the

**GENERAL AIR EXPRESS UNDER WAY**

**Transcontinental & Western Air and American Airways planes transfer shipments at Lambert Field, St. Louis, on the opening day of the new inter-line express service.**

autogiro is doing some campaigning on its own behalf. Kellett Autogiro Corporation recently delivered to a resident of Rio de Janeiro one of its latest Kinner-powered K-3 models. Two Pitcairn autogiros are causing considerable excitement in Argentine, where this type of aircraft had never been seen before. The demonstration flights are to continue in Uruguay and Brazil.

Brazil is the destination of fifteen Wright-powered Waco Straightwings, ten provided with light attack equipment and Browning machine guns and five with two-way radio and photographic apparatus. A plane of the same type was shipped to Brazil earlier in the year together with five commercial models for the use of Army pilots in carrying the mail and getting training in cross country flying. The present shipment totals about $200,000.

Forerunner of a line of military and commercial aircraft which the Argentine government plans to build at its new military aviation factory at Cordoba is a two-place low-wing monoplane, which is the first airplane completely designed and built in South America. Powered with the first 165-hp. Wright engine to be delivered of an order placed with the Wright Corporation some months ago under a license agreement, it has completed a 6,000-mile test flight to fourteen states of the Argentine Republic. Manufacture of the Wright engines at Cordoba under this license, the first to be granted a South American country by an American aircraft engine manufacturer, will begin immediately upon the return of the Argentine mission now studying production methods at the Wright factory in Paterson.

After a two year's test of parachute performance, the Mexican government has selected the Switlik Safety Chute for the use of its aeronautical division. Forty-two silk chutes of the 26-ft. seat type have been delivered.

Premier and Minister of War Manuel Azana of Spain has declared himself in the market for airplanes. A modern air force to make Spain a first-class air power is part of his reorganization plan for the Spanish Army, already numbering 150,000 men.

The first plane to carry a made-in-South Africa label has just received a certificate of airworthiness from the Civil Air Board. The Erasmus monoplane, a single-seater parasol type with an American Continental engine, was flown to a height of 8,000 ft. during its test.

While the fleet of twin-engined low-wing monoplane transports for United Air Lines is under construction in the Seattle factories of the Boeing Airplane Company, the Stearman Aircraft Company of Wichita, Kansas, also a United subsidiary, will furnish landing gears, tail-wheels, and a number of other finished parts. Completion of the first consignment of new transports is scheduled for early November.

Controllable pitch propellers by the Smith Engineering Company of Cleveland will be part of the standard equipment of the Beechcraft, which the Beech Aircraft Company at Wichita will have ready for the market early in the fall. The Gee Bee racer which Russell Boardman flies in the National Air Races will also have the Smith airscrew.

### *New wings for the Navy*

In the Buffalo plant of the Hall Aluminum Aircraft Corporation the largest flying boat in America is taking shape. Built to Navy specifications for long-distance patrol flying and heavy bombing, the experimental craft will be tested at the Naval Proving Station at Hampton Roads in September. No production contracts will be let until the acceptance of the new plane for fleet use by the naval aircraft inspection board. Like the most recent addition to the Royal Air Force, the Short Brothers' flying boat, the new naval plane is of metal construction. Four Curtiss Cyclone engines sustain a gross load of 20 tons. Six 820-hp. Rolls Royce engines power the British boat, which weighs 70,000 lb. fully loaded.

Naval training schools at Pensacola, Fla., and Lakehurst, N. J., turned out 202 qualified naval aviators during the past fiscal year. One hundred and seventy officers and enlisted men of the U. S. Navy and Marine Corps qualified for heavier-than-air service; 32 for the lighter-than-air division of the Navy.

Some 270 planes, ranging in size from single-seater fighters to multi-motored patrol seaplanes, staged the largest aerial demonstration ever held by the Navy at San Diego, just before the opening of the Olympic games. Aircraft from the visiting scouting force, as well as from the battle force unit regularly stationed in the Pacific, made up the unusually large cast. The maneuvers and review by the Assistant Secretary of the Navy and the Commander-in-Chief of the fleet culminated the annual aircraft tactical concentration and training period.

### *The R.A.F. fights it out*

The annual exercises of the air defense of Great Britain were planned on a smaller scale than usual this year. Between July 18 and 22 units of the "fighting area" defended their territory from the attack of the enemy across the southern frontier, which was the south coast of England. No operations were allowed over London, dubbed for the session a mountain range. The main object of the exercises was to test the capacities of twelve fighter squadrons, especially those equipped with new interceptor fighters to which have been attributed speeds of some 215 to 220 m.p.h.

Lloyd's Register and the British Corporation which for the past three years have handled the inspection of certain classes of aircraft for the renewal of certificates of airworthiness, have merged their aviation interests. The Joint Aviation Advisory Committee, on which will sit 32 representatives of aircraft constructors, insurance interests, and air transport and operating companies, as well as two members of each of the original aviation committees, plans to organize the classification of civil aircraft on lines similar to those applied to shipping by Lloyd's Register for the last two and a half centuries. This is a major move toward the supersession of government regulation of the aircraft industry by self-regulation, a tendency which has gone farther in almost all European countries than in the United States.

### *Corporation reports*

Curtiss-Wright Corporation writes its report for the first six months of 1932 in black ink, with earnings equal to three cents a share on 1,141,214 outstanding class A shares. Net profit after depreciation, interest, and taxes was $32,358 compared with loss of $1,463,154 for the first half of last year. The profit was all made from operations during the first quarter of the year. For the second quarter, losses were $269,665; those of the second quarter of 1931, $375,030. Curtiss Aeroplane & Motor Company, Inc., manufacturing subsidiary of Curtiss-Wright, also made money in the first three months of this year, but not enough to offset losses in the second quarter of $109,335. Net loss during the first half of 1932 was $12,635, as against a profit of $33,545 for the same period last year.

National Aviation Corporation, an investment trust holding aviation securities, reports a consolidated net loss of $501,710 during the six months ending June 30, due largely to losses from the sale of securities. Losses in the first half of 1931 totaled $738,330. The 125,400 shares of Aviation Corporation, which made up the largest individual holding in the portfolio at the beginning of the year, has been disposed of. Understanding is that E. L. Cord was the purchaser.

National Air Transport, Inc., subsidiary of United Aircraft & Transport Corporation, reports net profit of $66,-154 after taxes and other charges for the first six months of 1932—equal to 10 cents a share on 650,000 no par shares outstanding, as compared with 49 cents a share for the first six months of last year. To operations during the second quarter of the year are due the favorable reports for the first six months. Net profit for the second quarter was $72,904. In the three months ending June 30, 1931, the company earned $203,674, or 31 cents a share.

### *Personnel*

Col. Halsey Dunwoody, vice-president and general manager of the Cen-

tral Division of American Airways and formerly executive vice-president of Universal Aviation Corporation, which was absorbed by American Airways, has announced his resignation. With the centralization of the company's operations in St. Louis, C. R. Smith, vice-president in charge of the Southern Division of American Airways was made vice-president in charge of operations of the entire system, and F. Warren Oakes vice-president in charge of traffic.

Larry G. Fritz is now superintendent of the Eastern Region of Transcontinental and Western Air, with jurisdiction over the territory from Kansas City to New York and from Chicago as far south as Oklahoma City. His experience in aviation began in 1917, when he was a member of the Royal Air Force, and includes a major part in the organization of Maddux Air Lines, now a part of Transcontinental and Western Air.

Commander Frank C. McCord, commanding officer of the U.S.S. Los Angeles until its recent retirement, has been ordered to the U.S.S. Akron for instruction as prospective commanding officer.

Harry A. Sutton, ex-Army flier and formerly chief engineer and vice-president of American Airways, has been appointed test pilot and research engineer for Curtiss Aeroplane & Motor Company. In 1929, Mr. Sutton received the Distinguished Flying Cross and the Mackay Trophy as a result of his research on spinning at the Flight Test Section of the Material Division at Wright Field.

James H. Colwell, chief of the Aeronautics division of the Patent Office since its formation, is among those affected by the compulsory retirement provision of the recently enacted economy legislation. Directly connected with aviation since its infancy, Mr. Colwell played an important part in its development in this country.

Sir John Salmond, Chief of the British Air Staff, in accordance with his policy of accelerating promotion in the junior ranks, has announced his resignation. His brother Sir Geoffrey Salmond, who served in the Royal Flying Corps during the War, commanded the R.A.F. in India and last year was appointed Air Officer Commander-in-Chief of the Air Defense of Great Britain, will take his place in April, 1933.

At a recent meeting of the Council of the Royal Aeronautical Society C. R. Fairey was re-elected president, and Professor L. Bairstow, Air Marshall Sir R. Brooke-Popham, and A. F. Sidgreaves chosen as vice-presidents for the coming year.

# SIDE SLIPS

*By Robert R. Osborn*

WE ARE enthusiastic about the proposal of the Polish flying team, which is coming over to participate in the National Air Races, that a "perpendicular" race be held. In this race, designed primarily to interest builders of military aircraft, the contestants would climb to 25,000 feet and

then dive down to a finish line in front of the judges' stand. As very little of this race would be visible to the spectators you may wonder why we like the idea. Our thought is that this would be at least one period during the races when the field, stands and surrounding countryside would be free of speeding airplanes darting around in the bushes and under trees, knocking ice cream cones out of children's hands and frightening dowagers. At last year's races it finally got so that we didn't dare go through the gate at the end of the field without looking around to make sure that some whizzing Monocoupe or Gee Bee wasn't expecting to use the same gate.

We are surprised to read that the qualifying high speed for this year's Thompson Trophy Race will be 200 m.p.h. We had expected that that would be the limit for landing speed.

We see by the papers that "The world's airplane speed record has been broken by an Italian, with a speed of 430 m.p.h., but the record was invalidated by the loss of an elevation rudder on the last lap of the trial."

We protest against this ruling. We think that any pilot who can lose an elevation rudder at that speed, and escape personal invalidation, should be awarded the speed record with palms and oak leaves.

For a long time we have been worried about the disappearance of "Helen Lee," one of our most valued correspondents, upon whom we relied for news and gossip of Mexican aviation. Just as we were about to send a note to the State Department to suggest an investigation by our ambassador to Mexico, a letter came in from California from her. Aeronautically speaking, the most amazing things seem to happen in California and Mexico, and we are glad to hear that our sterling correspondent has moved from one section to the other.

She sends in a clipping from a magazine which cannot be named, but which, according to the legend in its masthead is "devoted to the progress of air travel in all parts of the world." The article therein states "All the world has acclaimed the feat of Amelia Earhart in making a solo flight across the Pacific. She was the first woman ever to travel as an airplane passenger across the dreary expanse of the Pacific, and now, alone in her own plane, she has made the trip a second time.

Sometimes it is very difficult to keep track of the outstanding flights, and we can sympathize with this magazine in its confusion. We have never been entirely straightened out since the time Mr. Levine and an English pilot made a distance flight from Paris toward India, instead of toward New York, as previously announced, "because the weather was better in that direction."

We are not sure that there is any connection between the two news items, but we must say that the coincidence that they have appeared at the same time is very disturbing. We read that the two head men of the New York gang "underworld" are taking flying

lessons at Roosevelt Field, and that a Connecticut inventor has developed a device by means of which airplane passengers can be picked out of their seats and dropped overboard by the mere pushing of a button by the pilot.

"Mr. Blank attempted to pull out of the spin,—a trick to which experienced pilots often resort." Found in a New York state paper by H.W.P of Delmar, N. Y., who comments, "If pilots don't often resort to that trick—to attempt to pull out of the spin, they never become experienced,—right?"

# STATISTICS OF THE MONTH

*Supplementing the statistical issue of* AVIATION, *March, 1932. Page numbers refer to that issue.*

### PRODUCTION AND LICENSING
*(pages 118-128)*

THE total of licensed flying personnel, constant at about 30,000 during all of 1931, has decreased almost 2,000 since the beginning of this year. Licensed pilots, numbering 18,434 at the end of July, continue to increase gradually, but not nearly fast enough to counteract the rapid drop in valid student permits, which totaled only 10,406 at that date. Practically no change is observed in the number of aircraft legally approved for service. Licensed aircraft have not left the 7,400's since mid-March, identified planes varied even less. The figures at the end of July were 7,440 and 3,216 respectively.

### AIR MAIL
*(page 107)*

IN the air mail table, below, the figures for average compensation per mile flown are abnormal because of the unusually low compensation to contractors during the month of June, on account of the limited funds available at the end of the fiscal year.

**Air Mail Carried by Routes**
*(Second Quarter, 1932)*

| | Miles of service | | Total weight of mail dispatched (pounds) | | Amount paid to contractor | Average compensation per mile flown |
|---|---|---|---|---|---|---|
| American Airways | Scheduled | Actually flown | 1932 | 1931 | | |
| 1. Boston-New York | 68,800 | 63,812 | 33,416 | 35,155 | $30,108.49 | $0.47 |
| 2. Chicago-Memphis | 141,284 | 139,580 | 16,055 | 19,342 | 73,474.46 | 0.53 |
| 20. New York-Forth Worth | 505,833 | 463,953 | 69,632 | 33,015 | 229,725.17 | 0.50 |
| 21. Dallas-Galveston | 62,521 | 62,096 | 9,007 | 9,760 | 26,841.30 | 0.43 |
| 22. Dallas-Brownsville | 102,624 | 102,386 | 21,055 | 21,566 | 51,098.67 | 0.50 |
| 23. Atlanta-New Orleans | 78,260 | 77,974 | 24,593 | 26,180 | 28,153.04 | 0.36 |
| 24. Chicago-Cincinnati | 100,342 | 96,675 | 17,578 | 21,315 | 44,565.18 | 0.46 |
| 29. New Orleans-Houston | 59,798 | 59,541 | 12,449 | 12,964 | 21,571.27 | 0.36 |
| 30. Omaha-Atlanta | 335,426 | 330,385 | 74,312 | 62,850 | 154,204.88 | 0.47 |
| 33. Atlanta-Los Angeles | 619,312 | 613,565 | 75,506 | 54,141 | 418,594.30 | 0.70 |
| Total | 2,074,200 | 2,009,967 | 343,603 | 329,250* | $1,088,336.76 | 0.54 |
| Eastern Air Transport | | | | | | |
| 19. New York-Miami | 922,185 | 899,445 | 224,680 | 238,147 | 397,218.77 | 0.44 |
| National Parks Airways | | | | | | |
| 26. Great Falls-Salt Lake City | 185,380 | 183,116 | 13,869 | 15,811 | 80,460.90 | 0.44 |
| Northwest Airways | | | | | | |
| 9. Chicago-Pembina | 398,393 | 393,931 | 69,059 | 69,618 | 196,829.58 | 0.50 |
| Pennsylvania Air Lines | | | | | | |
| 11. Washington-Cleveland | 183,212 | 157,794 | 33,739 | 18,890 | 53,501.86 | 0.34 |
| Transamerican Airlines | | | | | | |
| 27. Bay City-Chicago | 387,187 | 371,089 | 46,126 | 47,328 | 140,479.61 | 0.38 |
| Transcontinental & Western Air | | | | | | |
| 34. New York-Los Angeles | 1,166,883 | 1,128,431 | 312,036 | 114,999 | 731,516.22 | 0.65 |
| Western Air Express | | | | | | |
| 4. Salt Lake City-San Diego | 142,324 | 141,622 | 15,178 | 172,787 | 53,867.95 | 0.38 |
| 12. Cheyenne-Albuquerque-Amarillo | 156,884 | 150,390 | 30,764 | 17,379 | 70,107.98 | 0.47 |
| 33. Albuquerque-El Paso | 40,404 | 39,738 | 2,442 | ..... | 26,571.85 | 0.67 |
| Total | 339,612 | 331,750 | 48,384 | 190,166 | 150,547.78 | 0.46 |
| United Air Lines | | | | | | |
| 3. Chicago-Dallas | 464,914 | 459,695 | 134,089 | 148,580 | 240,455.22 | 0.52 |
| 5. Salt Lake City-Seattle | 319,228 | 318,257 | 68,844 | 90,614 | 178,321.61 | 0.56 |
| 8. Seattle-San Diego | 445,414 | 442,797 | 112,431 | 91,388 | 216,637.38 | 0.50 |
| 17. New York-Chicago | 622,728 | 584,363 | 337,383 | 456,499 | 294,351.14 | 0.50 |
| 18. Chicago-San Francisco | 1,153,880 | 1,135,892 | 299,350 | 469,149 | 705,846.92 | 0.62 |
| Total | 3,006,164 | 2,941,004 | 952,097 | 1,256,230 | 1,635,612.27 | 0.56 |
| United States Airways | | | | | | |
| 30. Kansas City-Denver | 115,328 | 113,767 | 5,297 | 2,578 | 33,569.13 | 0.30 |
| Total | 8,778,534 | 8,530,294 | 2,058,920 | 2,283,017 | 4,498,072.88 | 0.53 |

*Includes routes 16 and 28, discontinued in the second half of 1931.

**Makes of Newly Licensed and Identified Aircraft**
*(Second Quarter, 1932)*

| | Licensed | Identified | Total |
|---|---|---|---|
| Aeronca—Open | 12 | .. | 12 |
| Aeronca—Closed | 6 | .. | 6 |
| American Airplane & Engine (ten-place) | 10 | .. | 10 |
| American Eaglet | 3 | .. | 3 |
| Bird | 7 | .. | 7 |
| Buhl Pup | 3 | .. | 3 |
| Consolidated-Fleet | 3 | .. | 3 |
| Consolidated Fleetster | .. | 2 | 2 |
| Curtiss-Wright Travelair Biplane | 5 | .. | 5 |
| Ford | 3 | .. | 3 |
| Fairchild 22 | .. | 7 | 7 |
| Fairchild 24 | .. | 5 | 5 |
| Heath | .. | 11 | 11 |
| Kellett Autogiro | 1 | 2 | 3 |
| Mono Aircraft | 17 | 1 | 18 |
| Nicholas Beasley | 6 | 2 | 8 |
| Rearwin | 3 | .. | 3 |
| Stinson four-place | 12 | .. | 12 |
| Stinson Airliner | 1 | .. | 1 |
| Taylor Cub | .. | 10 | 10 |
| Waco—Open | 5 | .. | 5 |
| Waco—Closed | 10 | .. | 10 |
| Miscellaneous | 18 | 63 | 81 |
| Total | 125 | 103 | 228 |

All makes having three or more planes licensed or identified are listed above.

**Makes of Engines in Newly Licensed or Identified Aircraft**
*(Second Quarter, 1932)*

| | Licensed | Identified | Total |
|---|---|---|---|
| Aeronca | 18 | 2 | 20 |
| American Cirrus | 2 | 14 | 16 |
| Continental | 11 | 13 | 24 |
| Ford | .. | 13 | 13 |
| Genet | 5 | 1 | 6 |
| Heath B-4 | .. | 5 | 5 |
| Heath-Henderson | .. | 5 | 5 |
| Henderson | .. | 10 | 10 |
| Jacobs | 4 | .. | 4 |
| Kinner K-5 | 5 | 1 | 6 |
| Kinner B-5 | 5 | .. | 5 |
| Kinner C-5 | 1 | 2 | 3 |
| Lambert | 10 | 1 | 11 |
| Lambert Velie | .. | 2 | 2 |
| Lycoming | 13 | .. | 13 |
| Menasco | 1 | 3 | 4 |
| P. & W. Wasp | 5 | .. | 5 |
| P. & W. Wasp Jr. | 2 | .. | 2 |
| P. & W. Hornet | 4 | .. | 4 |
| Szekeley | 6 | 2 | 8 |
| Warner Scarab | 9 | .. | 9 |
| Wright 165 | 4 | .. | 4 |
| Wright 240 | 2 | .. | 2 |
| Wright 300 | 2 | .. | 2 |
| Wright Cyclone | 8 | 2 | 10 |
| OX5 | .. | 3 | 3 |
| Church Marathon | .. | 5 | 5 |
| Miscellaneous | 8 | 19 | 27 |
| Total | 125 | 103 | 228 |

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# FLYING EQUIPMENT

## Air cruiser for the Coast Guard

DESIGNED especially for the requirements of Coast Guard service, the General Aviation Manufacturing Corporation of Dundalk, Md., has just delivered to the United States Coast Guard the first of five flying boats. In patroling our shores, the Coast Guard aviation must be prepared to face a variety of conditions which impose requirements over and above those which must be met by commercial or the ordinary military aircraft. The Coast Guard flying boats must be prepared to cover wide areas of open water in all sorts of weather, and must carry a full complement of radio equipment so that they can keep in touch with shore stations at all times. They must be able not only to bring ashore from ships at sea injured or sick personnel, but must also be able to stand by in rough water to take off or to assist the crews of sinking surface craft. Moreover, in these days of rum-running and other smuggling activities, they must carry a certain amount of offensive armament in the form of machine guns. Ships must be designed not only to be airworthy and seaworthy, but also designed to permit beaching under their own power without the assistance of outside crews.

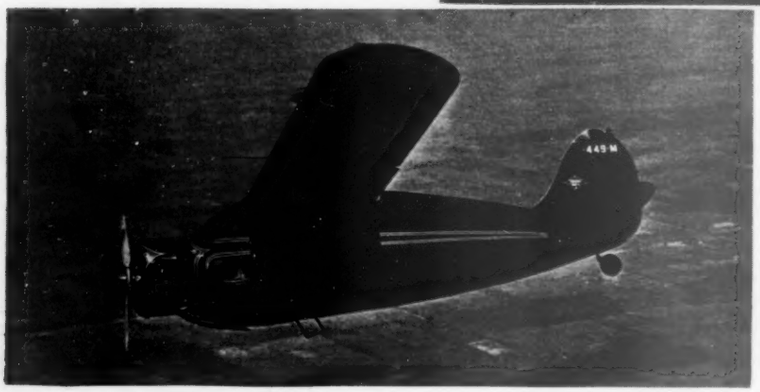
The Antares, the first of the fleet to be delivered, is a monoplane flying boat powered with two Pratt & Whitney Wasp engines, mounted as pushers in nacelles above the wing. The principal materials in the hull proper are aluminum and Alclad. The former being employed only for gas tanks, and the latter making up practically the entire remainder. The wing with the exception of chrome-molybdenum fittings is entirely of wood, and the tail surfaces and engine mounts are of chrome-molybdenum steel tubing. It was necessary to take unusual care throughout the construction to protect the parts against attack by salt water. All the aluminum parts were anodically treated, primed with red oxide, and then coated with two or three coats of pigmented varnish. Impregnated fabric strips are inserted between every joint. All steel parts are cadmium plated, primed with red oxide and painted. Linseed oil is used for its interior of all steel members. Many coats of varnish were applied to all wood members for their protection.

The main hull is 54 ft. long, with an 86-in. maximum beam, and has a displacement of 57,000 lb. It is divided into two parts, the hull proper, which constitutes the main cabin space, the flotation, sections, and the support for wings and engines, and the tail part, which is of a true monocoque design. Three watertight bulkheads divide the boat's hull into four separate compartments.

The wing is an internally-braced cantilever, built in one piece with a span of 74 ft. 2 in. The two principal spars take the bending moments, and the skin is designed to take all torsional and shear stresses. The ailerons are of Alclad.

The two Wasp engines are mounted in streamlined nacelles above the center section of the wing. The supporting struts are of a simple arrangement and are well streamlined. Each engine drives a three-bladed aluminum alloy propeller. The use of ring cowling on a pusher power-plant installation is again to be noted. The oil tanks are mounted in the nacelles, an adjustable shutter in the nose of each permits oil temperature control.

Although the machine is in no sense an amphibion, it is equipped with built-in beaching gear. Two standard air wheels are supported on stiff struts which can be folded back into the lower surface of the wing on each side of the hull. They are not designed for land-




**At top: The Parks P-1H, powered with a Kinner K-5. Right: First of the Coast Guard's new flying boats. Below: Model R Stinson with its landing gear retracted.**

ings ashore, but can be let down when the hull is afloat, and are sufficiently strong to permit taxing the machine up a beach or a ramp.

Since radio is so important in coast patrol work, the machine itself was almost literally designed around the radio equipment. The radio room is behind the pilot's seat and extends along one entire side of the cabin for about six feet. Trailing and fixed antenna equipment are provided, and full transmitting and receiving equipment for short and long wave work has been installed. The pilot's compartment is fitted with the latest in navigational and flying instruments. Due to the location of the cockpit, visibility forward and above is excellent.

The general specifications of this airplane as given by the manufacturer are as follows: Span, 74 ft. 2 in.; length, 53 ft. 6 in.; overall height, 15 ft. 6 in.; gross weight, 11,200 lb.; weight empty, 7,000 lb.; wing area, 754 sq.ft.; beam of hull, 7 ft. 2 in.; range, 1,100 miles.

## Stinson introduces a retracting gear

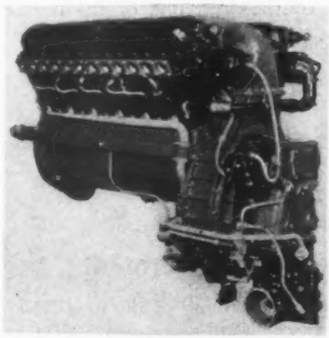
THE retracting landing gear which was predicted in certain quarters at the time the new Model R Stinson (AVIATION, March, 1932) appeared, has just been announced by B. D. DeWeese, vice-president and general manager of the Stinson Aircraft Corporation. Three new models are covered by the announcement. The R-1 is identical to the previous Model R except that it has a retracting landing gear. The R-2 is identical with the model "R" except that a Lycoming 240-hp. transport engine using 80 octane fuel has been installed. The R-3 is similar to the R-2 except that the retracting landing gear is installed. The latter two models are being offered for light feeder service for mail and passengers on transport lines, and the Model R and the new R-1 are suggested for private use.

The wing stubs and general mechanical construction of the Model "R" foreshadowed the installation of the retracting gear. Space has been provided so that the landing wheels are pulled inward and upward into wells in the bottom of the fuselage. The retraction is accomplished by means of cables operating around a drum driven through a 20 to 1 worm gear reduction. Lowering the wheels is accomplished by releasing a dog clutch between the worm gear and the drum. A lever operated by the pilot disengages the clutch, and the landing gear drops free to a self-locking landing position. Hydraulic arresting cylinders reduce the shock on all moving parts of the mechanism. Mechanical and electrical tell-tales in the cockpit warn the pilot as to whether the wheels are retracted or extended and locked.

## The Parks P-1H trainer

A THREE-PLACE open biplane based on the original Detroit-Parks design is now being produced by the Hammond Aircraft Corporation of Ann Arbor, Mich. The machine is an open biplane of conventional design powered with a Kinner K-5 engine. It carries an unusually wide tread landing gear for a biplane. Each wheel is carried on a triangular framework, the two lower members of which are attached to the lower longerons, and the third member (which incorporates an oleo leg) is attached to the upper longerons near the forward cabane fittings.

An unusual feature of this machine, sometimes overlooked in airplanes of this class, is the installation of bushings at all wearing points. All landing gear fittings are mounted on large bushed bearings, and all controls and control hinges are similarly fitted. Attention has been paid to the accessibility of fittings so that bushings may be easily replaced without extensive teardown.



New Curtiss Conqueror.

Its specifications as given by the manufacturer are: Length, 23 ft. 6 in.; height, 9 ft. 2 in.; span, upper wing, 30 ft. 1 in.; span, lower wing, 28 ft. 8 in.; wing area, including ailerons, 290 sq.ft.; weight empty, 1,202 lb.; useful load, 788 lb.; gross weight, 1,990 lb.

## Wright announces a new Conqueror series

A 500-HOUR endurance test was recently completed on an unsupercharged Prestone-cooled unit of the new series of Curtiss Conqueror engines with highly gratifying results. At the end of the test series, the engine was torn down and found to be in excellent condition.

The first 100-hour period was run at full throttle and was followed by the regulation 100-hour Army test. The engine was then torn down and, with no adjustment other than grinding valves, reassembled and subjected to a 300-hour run simulating flight conditions. Throughout the full throttle operation and afterward, the engine developed 620 hp. or 20 hp. more than the rated figure. The tests were observed officially and conducted in accord with air corps specifications. Ten overspeed tests, in which the crankshaft reached 3,500 r.p.m., equivalent of a 375-m.p.h. power dive, also were conducted on the engine.

The new series of Conquerors was recently announced by the Wright Aeronautical Corporation, and retains the general form and many of the features of the older engine, but the engineering development has been carried to the point where both the geared and the direct-drive models may be operated with Prestone as the coolant. In addition, a new engine has been added to the series, a supercharged Conqueror, which developed the full-rated power output up to altitudes of 12,000 ft.

The advantages of using Prestone are well recognized. Since the radiator which must be used is only about 35 per cent of the size of that required for water-cooled models, a considerable saving in weight and an appreciable reduction in airplane drag due to smaller radiator size is accomplished.

The rated crankshaft speeds and horsepowers of the new Conquerors remain the same as that for the water-cooled models. That is, there are three standard engines, all of 1,570 cu.in. displacement, the direct drive being rated at 600 hp. at 2,400 r.p.m.; the two to one gear drive rated at 600 hp. at 2,450 r.p.m. and the seven to five geared model rated at 600 hp. at 2,450 r.p.m. Under normal conditions of temperature and pressure all three engines deliver in excess of 650 hp. at their rated speed. The new engines incorporate all the recent improvements which have been made over earlier models. The steel cylinder sleeves are now built with closed ends. Forged aluminum pistons are standard equipment, and the addition of counterbalance weights to the crankshaft has reduced main bearing loads and relieved stresses in the shaft.

The supercharged engine, which will deliver 600 hp. up to 12,000 ft., is similar in general design and construction to the other models. It uses the same major parts, with the exception of those which are peculiar to the supercharger itself and those which had to be modified to accommodate accessories which had to be moved by the addition of the supercharger. The latter is of the built-in centrifugal type and is housed at the rear end, driven through a long hollow shaft with the required flexibility to remove all shocks from the gears and bearings. The supercharger rotor is driven at ten times crankshaft speed. To prevent damage to the engine in flight near sea level, a throttle stop, either of the manual or automatic type, must be used.

# DESIGN NOVELTIES

## Tail wheel assembly

THE after part of the fuselage of the new Stearman 4CM1 mail plane shows a number of interesting design features. Contrary to usual practice, the fuselage framing ends in a triangular section whose apex is at the point of connection of the two upper longerons, and whose base is formed by a short piece of tubing separating the lower longerons. This consrtuction provides three points of support for the tail wheel assembly, and permits the mounting of all tail wheel parts outside the fuselage proper where they are completley accesible for inspection, repair, or adjustment. The tail wheel assembly may be removed by taking out three bolts without disturbing any part of the fuselage or other tail units—an ideal arrangement from the point of view of the maintenance man.

## Servo rudder on the Boeing 80A

ALTHOUGH the value of the servo principle has long been recognized and put into practical application on certain large British bombers, its first appearance in this country has been on the Boeing model 80A, three-engined transport now in operation between Chicago and the West Coast. A streamlined metal flap about 6 in. in chord and extending the full height of the rudder, is carried on a series of five brackets welded into the trailing edge. A pair of cables attached to the ends of short control horns at the mid-point of the flap run forward to a set of brackets attached rigidly to the fin post. The normal rudder controls are not disturbed in any way, nor are they attached to the servo control. As the rudder is swung the cables and brackets on fin and servo flap form a parallelogram linkage which keeps the flap axis parallel to the fin axis for any rudder position. The angularity of the flap with respect to the rudder varies, therefore, depending upon the degree of displacement of the rudder.

Before the application of the servo, it required an applied load of 90 lb. at the rudder bar to maintain a straight flight course with one of the outboard engines stopped. With the servo in action, the pedal load under similar circumstances was reduced to 12 lb. The same principle has also been applied to the new Boeing bombers recently delivered to the Air Corps.

## Lower wing baggage compartment

THE lower wing of the new Bellanca Airbus sesquiplane provides a practical and convenient place for the stowage of passengers' baggage. Two large hinged covers give access to the inside of the wing stub adjacent to the fuselage. Not only does this system make more cabin room available, but it also improves the longitudinal balance of the airplane as baggage weights are thus concentrated near the center of gravity. A somewhat similar arrangement has appeared on the new Stinson transport described in AVIATION for June, page 280.

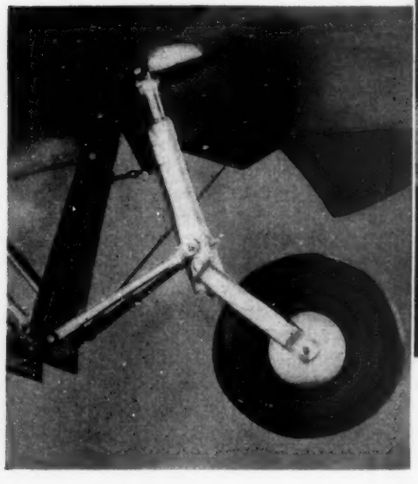
## Cockpit door latch arrangement

THE latest Cub by Taylor Aircraft of Bradford is equipped with an ingenious latch arrangement which permits the instant opening of the wide flap type door common to both cockpits. A pair of small spring bolts are mounted horizontally fore and aft on the edge of the door. The plungers of the bolts are connected together by a piece of flexible cable. Pressure against the cable at any point releases both latches.

## Belly compartments for baggage

THE location of baggage space in the belly of the American Airways Pilgrim type of transport has proven efficient from the point of view of traffic attendants and pleasant from the point of view of passengers. Access to these compartments under the floor of the cabin is from outside the plane. This permits handling baggage without interference with the movement of passengers. The compartments are conveniently placed and therefore readily accessible, reducing any possible delay on that score to a minimum.

The compartments enable efficient distribution of the weight contributed by baggage. There is no need for undesirable concentration in the tail, since they are so located that any distribution of weight may be made.



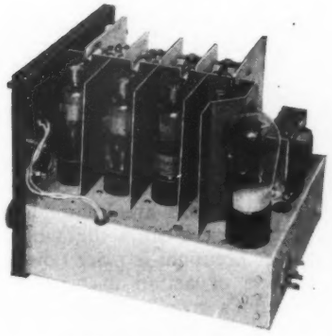
**Left: The Stearman tail wheel. Above: The Boeing 80A servo rudder. Right: The Bellanca wing compartment.**

*Aviation*

# THE BUYERS' LOG BOOK

## *Radio for the small plane*

Lear Developments, Inc., of 847 West Harrison Street, Chicago, Ill., have announced a compact radio receiving set for the private aircraft owner. "Radio-Aire" is a combined radio beacon signal, weather report and program broadcast receiver which can be easily installed in any type of airplane. The entire set is 7in.x7in.x8in. in overall dimensions and weighs 7 lb. complete with its 5 tubes. It may be arranged for either direct or remote control. The single control covers a frequency range from 235 to 720 kilocycles.—AVIATION, *September, 1932.*



Lear radio receiver.

## *Magnetic plug*

A magnetic plug, designed to replace the usual oil sump drain plugs on gasoline engines of all types, for the purpose of removing small metallic particles from a lubricating oil supply, has recently been placed on the market by the Bock Manufacturing Company, 1611 Farnam Street, Omaha, Neb. The trade name "Magplug" has been applied to this device.

The body of the plug is of bronze, provided with the usual thread and a square external head for the application of a wrench. A highly magnetized U-shaped piece of specially treated cobalt steel is pressed into a recess on the inner face of the plug. The magnet picks up pieces of steel or iron chips which may find their way into the lubricating system.—AVIATION, *September, 1932.*

Magplug showing accumulation of metallic chips, after a 25-hour test run, in a radial aircraft engine.

## *Dope in small lots*

Berry Brothers, of Detroit, Mich., are now marketing their standard line of aircaft dopes, put up in 8-oz. bottles. This arrangement makes these materials available to private airplane owners, model builders, etc., for refinishing and touch-up work.—AVIATION, *September, 1932.*

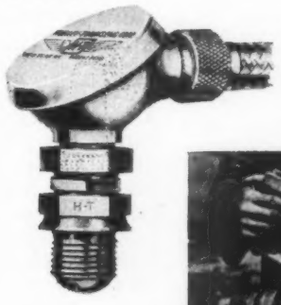
## *Purolator filters*

Several varieties of filters, embodying the "Purolator" principle, well known to the automotive industry, have been developed to meet the demand for gasoline dispensing devices at airports. In all of these units the filtering elements consist of non-corrosive wire, flattened to a cross-section of 0.009-in. thickness and helically wound on a fluted brass cylinder. Spacing between turns is effected by embossing the flattened wire at one-eighth inch intervals with variation of spacing from .0005 in. to .005 in. The various types differ mainly in the number and area of filtering elements and in the physical form of the unit which is determined largely by the point in the gasoline line at which it is to be applied.

The most recent development is the GF-2 hose type filtering Purolator which is included in a hose nozzle unit, making it impossible for unfiltered gasoline to go into the tank. This unit is built into an aluminum housing, weighs 15.6 lb. complete and is fitted with the usual trigger type shut-off. A check valve in the bottom of the casing retains the foreign matter until it can be drained out through the plug in the bottom. Three elements, 1¾ in. in diameter, and 10 in. long, with 0.0015 in. flat wire spacing, are used.

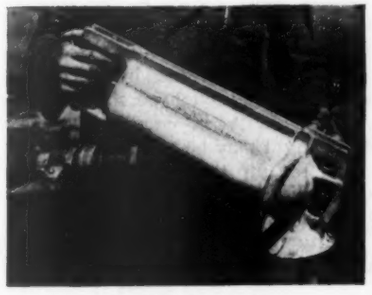
For fixed installation several other types are provided and may be installed in batteries, connected in parallel to provide any reasonable flow rate. One of the interesting features of these filters is the automatic pump cleaning device which consists of a pump plunger installed in such a manner that, by pulling a handle, the fuel flow can be momentarily reversed, flushing off the contamination collected on the outside or entering side of the filter element. Tests indicate that wire spacing of 0.001 to 0.0015 are most satisfactory for separating water from gasoline. — AVIATION, *September, 1932.*

Below: H-T spark plug Shielding.



## *Shielding for spark plugs*

Radio shielding for all types of H-T spark plugs has recently been announced by The Hurley-Townsend Corporation of 305 East 45th Street, New York. The device consists of a die-cast aluminum shield, which screws over the coupling nut of the spark plug. The housing is adequately ventilated for cooling and for the elimination of moisture condensation which might cause short circuiting. Terminals are made to fit all standard radio-shielded harnesses. The shield itself becomes an integral part of the harness and is not discarded when new plugs are fitted. Replacement plugs for the shield are sold at the same price as unshielded plugs. — AVIATION, *September, 1932.*



Purolator filter.

## *Rusco safety belt*

The Russell Manufacturing Company of Middletown, Conn., has recently marketed an improved type of aircraft safety belt, incorporating the Rusco-Dowd buckle. A high-strength safety belt is threaded through the buckle in the same manner as is a standard luggage strap, and the belt adjusted to the size of the wearer. Lifting a small release lever on top breaks the buckle down so that the wearer is instantly free.—AVIATION, *September, 1932.*

# TRANSPORT

## *Operations and Traffic Management*

### Policies on passengers outlined by airline

THE increase in passenger traffic on airlines has added emphasis to the element of responsibility shared by all airline employees in providing service that is satisfactory, particularly service that is safe. In anticipation of greater traffic expected this year, D. B. Colyer, vice-president of Boeing Air Transport has issued to all pilots and field employees a memorandum outlining the company's ideals regarding passenger handling and urging careful application of the company's policies.

Passenger safety comes first, of course. Therefore, it is a fundamental rule that no trips with passengers are to be started from any field when it is apparent the safety of the passengers is jeopardized, and trips started with passengers must return to the starting point or land (whichever appears most practicable) whenever the passenger's safety is to be jeopardized by proceeding. The ground and pilot personnel share the responsibility in deciding whether or not a flight may be safely undertaken. Once in the air the pilot has complete responsibility, aided by the information and advice supplied from the ground.

Operating performance records are considered at all times entirely secondary to the question of safety, and warning is given on the danger of being influenced against one's better judgment by the impatience and exhortations of passengers anxious to complete trips despite prevailing unsatisfactory conditions. The personal integrity and judgment of the ground and flying personnel is depended upon to make and apply sound decisions. Mail may be flown without passengers when the pilot considers conditions favorable for himself, if equipped with a parachute. Only when both the pilot assigned to a trip and the employee in charge of a station agree that conditions are favorable for carrying passengers can a flight be undertaken. A premium is placed on conservative line of action in accordance with the pilot's own judgment rather than on successful outcome of "taking chances." The reputation and commercial success of the company is recognized as depending directly upon the execution of these policies.

### De-icer experiments proving successful

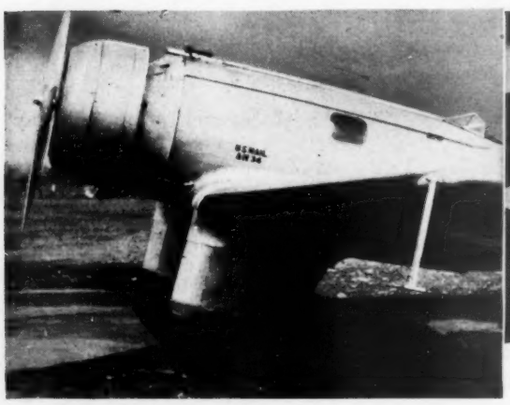
RESEARCH with Goodrich de-icers have been continued with success during the past season by Wesley L. Smith on a Northrop of Transcontinental & Western Air. The experimental use of the device under actual conditions has reached the point where it is deemed practicable to install them on all the company's mail planes next winter, and to test a larger unit on one of the company's tri-engined planes. The device is attached to the wing by an application of rubber cement which secures it tightly for service use but permits easy removal by hand.

### Brochure aids traffic sales

AMERICAN AIRWAYS is equipping its traffic representatives with a 9½x12¼-in. descriptive brochure for use in selling transportation to executives. Each of the 50 pages tells a separate story. Striking illustrations are liberally displayed throughout, the type is large and easy to read, the general make-up is attractive. One page emphasizes the speed element with map illustrating how this country has shrunk geographically with the advent of scheduled operations. Others discuss comfort, value, convenience, and so on. Four pages are devoted to an imaginary trip with explanations of each operation of the traffic department on the ground, the crew in the air and descriptions of each maneuver of the plane. Map and photographic illustrations of its various routes is one of the most interesting sections. This brochure is shown by the salesman or is left with the prospect for inspection.

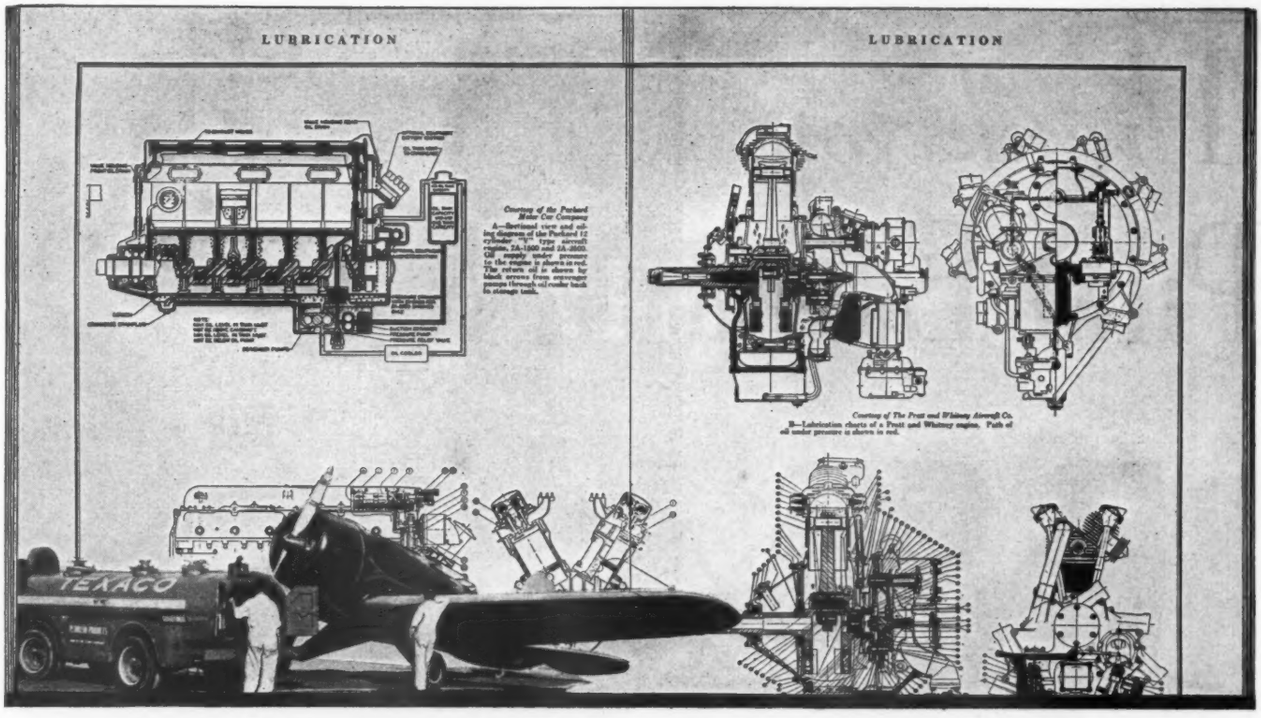
### Markings on apron aid terminal routine

MARKINGS on the concrete aprons to guide passenger planes to the loading position are arranged at the Candler Field, Atlanta, terminal of Eastern Air Transport to indicate the desired position for both the Condor and the Kingbird types. The transverse line indicating where the wheels of the Condor should come to rest so that the passenger door will be opposite the lane marked out for passengers is marked with a "C," that for the Kingbird with a "K." The wheel on the side toward the terminal building is lined up with a boundary line parallel with the building. These markings help speed up the loading and unloading operations and create an impression of smartness, efficiency and neatness.



*Aviation*

**Left: The Goodrich de-icer on the leading edge of a T.W. & A. Northrop mail plane. Above: Markings on the apron at Candler Field**

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# *Thank you.* Pilot Earhart!

AMELIA EARHART

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July 19, 1932.

B.G. Corporation,
136 W. 52nd Street,
New York City.

Gentlemen:

It is a pleasure to inform you that B.G. Spark Plugs did their share toward making my Atlantic hop of May 20-21 a successful one. Recently when I crossed the continent with one stop I relied on them again. While more or less spectacular flights may accentuate their good performance, every day reliability is just as important. I have used B.G.s for years, and can report as well on many unheralded hours of service they have given me in all parts of the United States.

May I congratulate the company which makes them and wish it continued success.

Sincerely yours,

Amelia Earhart

She flew the Atlantic for *"THE FUN OF IT"*

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***Contractors to the United States Army and Navy and Aircraft Engine Builders***

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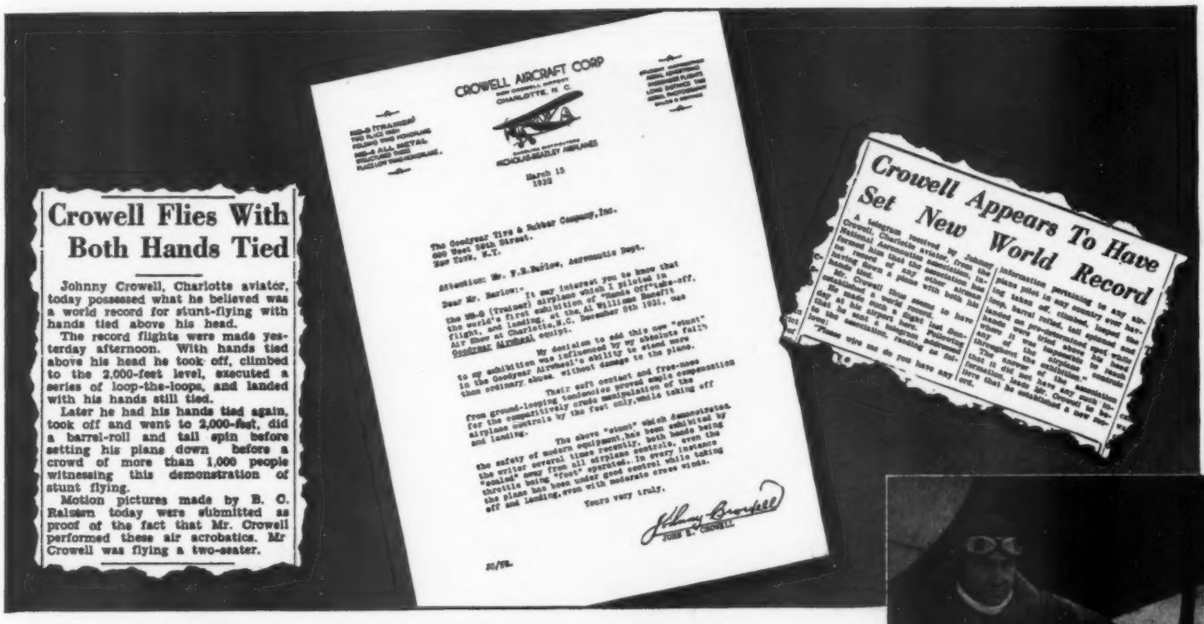
Crowell Flies With Both Hands Tied
Johnny Crowell, Charlotte aviator, today possessed what he believed was a world record for stunt-flying with hands tied above his head.
The record flights were made yesterday afternoon. With hands tied above his head he took off, climbed to the 2,000-feet level, executed a series of loop-the-loops, and landed with his hands still tied.
Later he had his hands tied again, took off and went to 2,000-feet, did a barrel-roll and tail spin before setting his plane down before a crowd of more than 1,000 people witnessing this demonstration of stunt flying.
Motion pictures made by B. C. Ralstorn today were submitted as proof of the fact that Mr. Crowell performed these air acrobatics. Mr Crowell was flying a two-seater.
CROWELL AIRCRAFT CORP
Crowell Appears To Have Set New World Record

# AIRWHEEL TIRES

## *share in "hands off" flying record*

**WITH both hands tied above his head, Johnny Crowell takes off, climbs to 2,000 feet, executes a series of loop-the-loops, a barrel roll or tailspin — then lands again with hands still tied.**

**And for the take-offs and landings made under these difficult conditions, the tire he chooses is AIRWHEEL.**

**Concerning this great big featherbed of a tire he says, "*The soft contact* and freeness from ground-looping tendencies proved ample compensation for the comparatively crude manipulation of the airplane controls by the feet only... In every instance the plane has been under good control while taking off and landing, even with *moderate cross winds.*"**

**Isn't that the tire you want on your ships for any kind of flying? More and more commercial flyers, airplane manufacturers and air transport fleets are adopting the Airwheel, for its safety, comfort, and reduction of maintenance costs.**

**For full information and engineering data, write to Goodyear, Akron, Ohio, or Los Angeles, California.**

**TUNE IN:**
**Goodyear invites you to hear the Revelers Quartet, Goodyear Concert-Dance Orchestra and a feature guest artist every Wednesday night, over N. B. C. Red Network, W E A F and Associated Stations**

GOODYEAR

**WHEN YOU BUY A NEW SHIP SPECIFY GOODYEAR AIRWHEELS**

# Fills a place all its own

THE usefulness and value of the Autogiro cannot be accurately measured by mere comparison of any one of its characteristics with that of other more familiar aircraft.

Its ability to land on and take off from almost any moderate size open ground gives the Autogiro a utility impossible to any heavier-than-air craft that is dependent upon large prepared airports. That is obvious.

The Autogiro affords security to pilot and passengers not approached by any other heavier-than-air craft. It can fly slowly as well as fast. It cannot fall off into a spin. It can settle gently to earth at little or no forward speed.

Even a bare comparison of speed, wherein the Autogiro is only slightly slower than many comparable airplanes, is misleading when it is considered that in the Autogiro you can almost always take off nearer to where you are and land nearer to where you want to go.

The market for the Autogiro is among those thousands of people who have recognized all the potential pleasure and utility of air travel but who have waited for a craft of wider, everyday practical usefulness and who value security above every other consideration.

AUTOGIRO COMPANY OF AMERICA ◂ ◂ PITCAIRN FIELD ◂ ◂ WILLOW GROVE, PA.

AUTOGIRO

# The "Caterpillar" helps them do it!

**Caterpillar Tractor Co., Peoria, Ill., U. S. A.**
Track-type Tractors Road Machinery
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| TWENTY-FIVE . | $1900 | SIXTY-FIVE . . . | $4350 |
| DIESEL . . . . | $6500 | | |

**CATERPILLAR**
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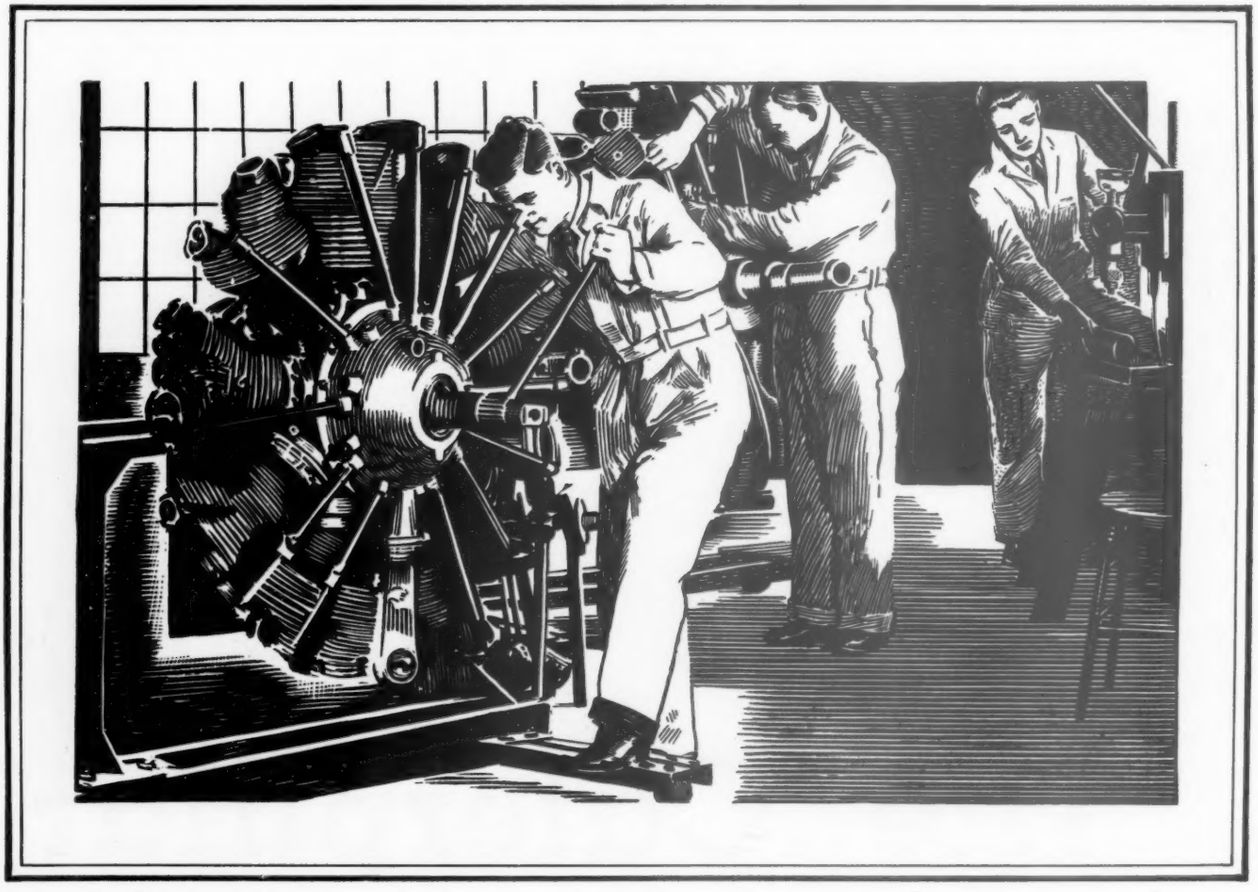
**TRACTOR**

SPACE is at a premium on this compact, busy field—but pilots and ground crew alike have constant, capable help in minding the sign. For a responsive, versatile "Caterpillar" Tractor "hostles" the planes to or from the hangars without bother or delay. Power and traction in balance—quick nimbleness to turn on its heel in close quarters—the tireless "Caterpillar" hauls, smooths the field, repairs and improves as needs suggest.

"Caterpillar" Tractors do scores of useful chores around the flying field, large or small—the country over, they're adding to the safety, convenience and economy of airport management.

# Are FREQUENT OVERHAULS Wasting Money for You?



WHETHER you're a sportsman pilot or head of a transport company, you can easily cut repair and overhaul costs. Many of the world's finest air lines now use Pennzoil exclusively for just one reason. It definitely lengthens the time between overhauls and cuts cost per flying mile.

Pennzoil now lubricates transport planes on over 59,600 scheduled miles daily. After careful tests, it is used exclusively by these famous transport companies:

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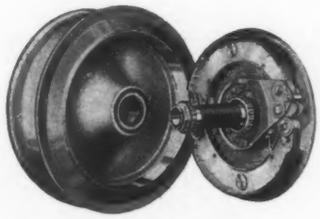

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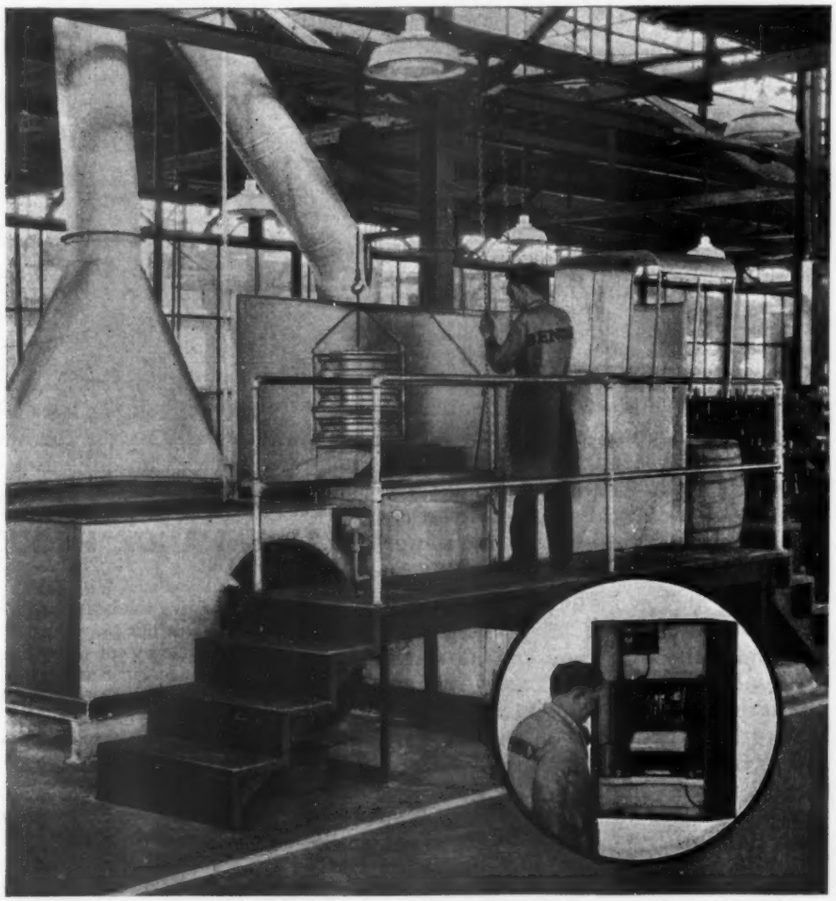

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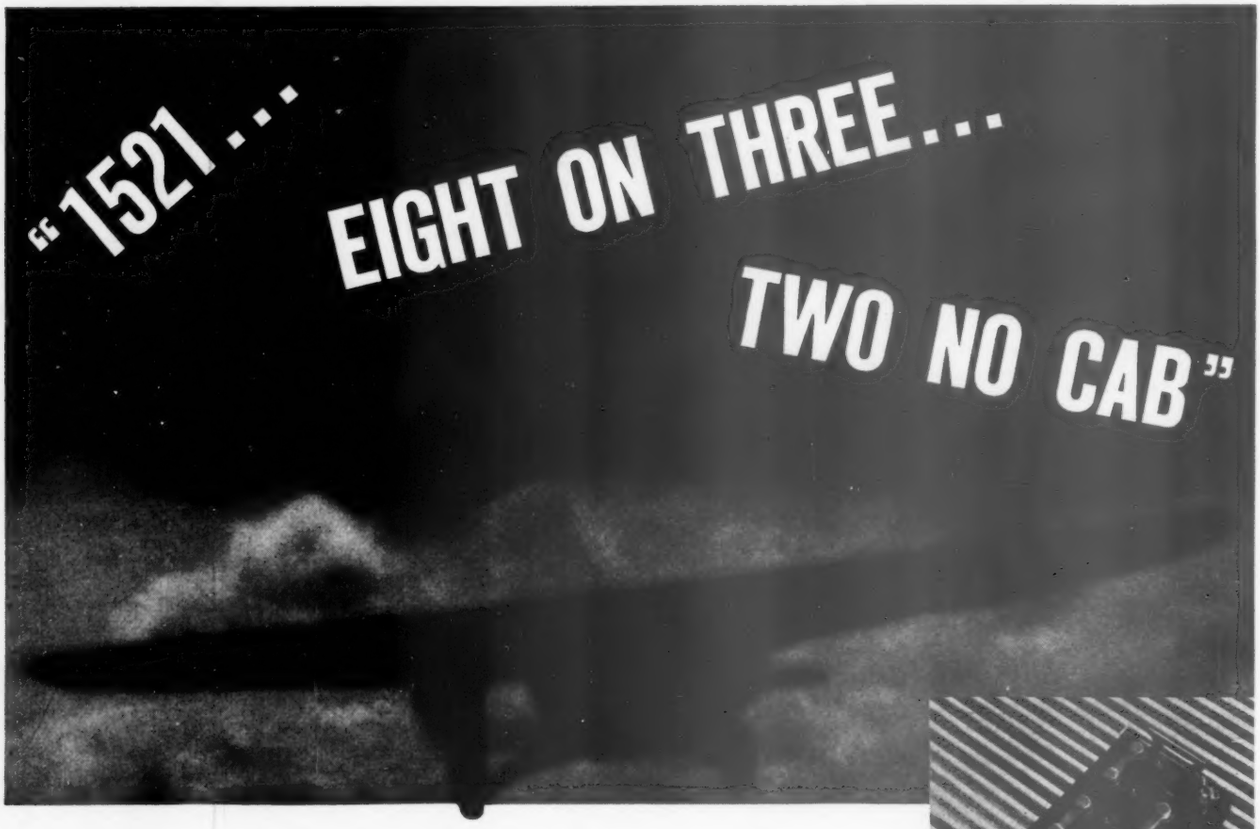


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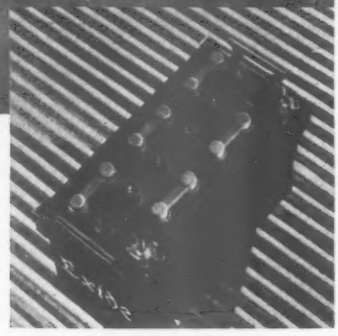

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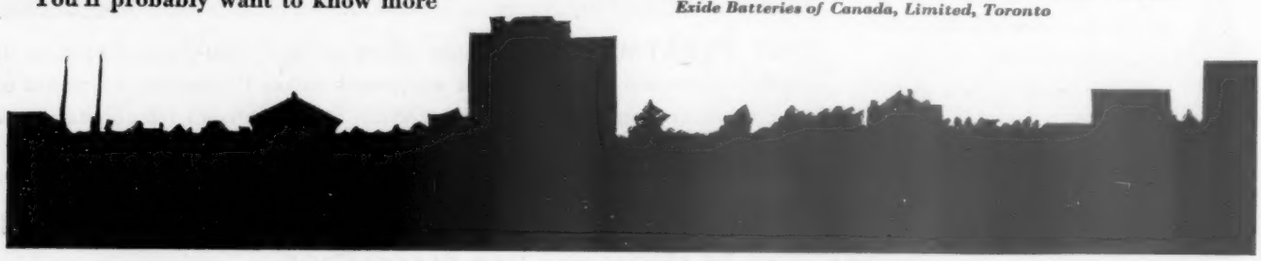

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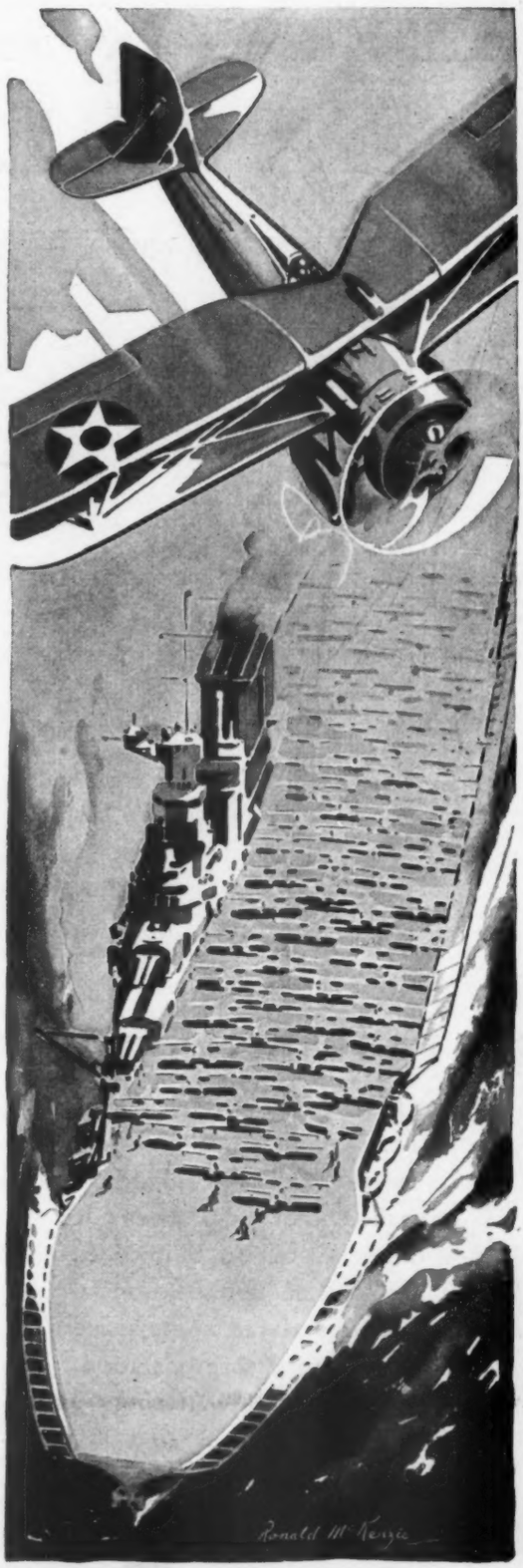


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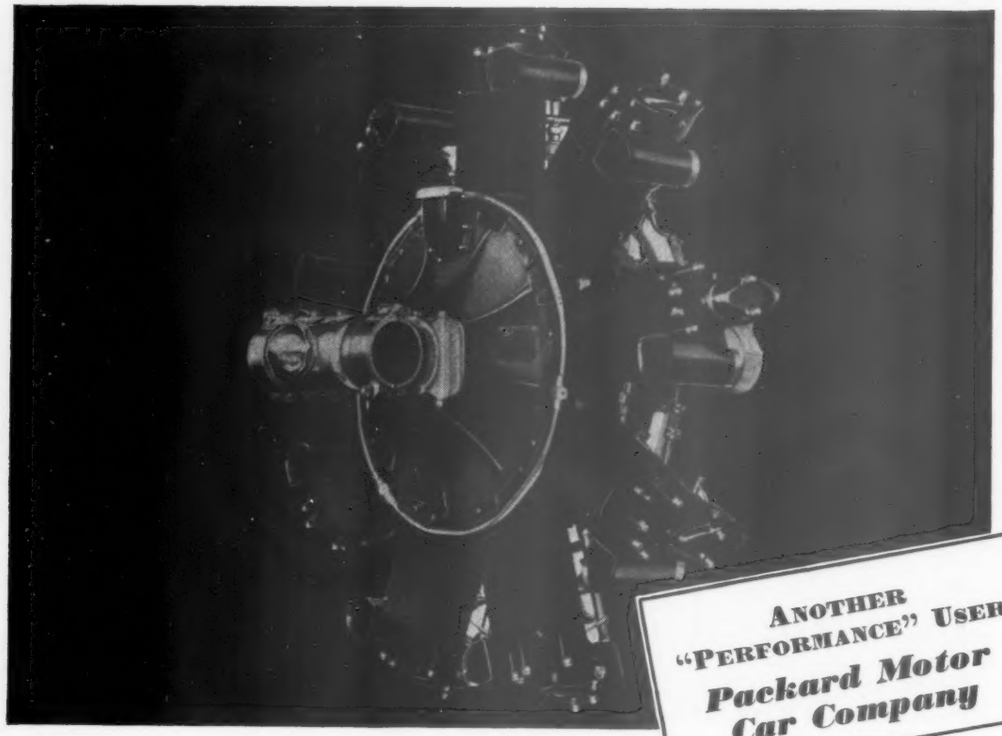

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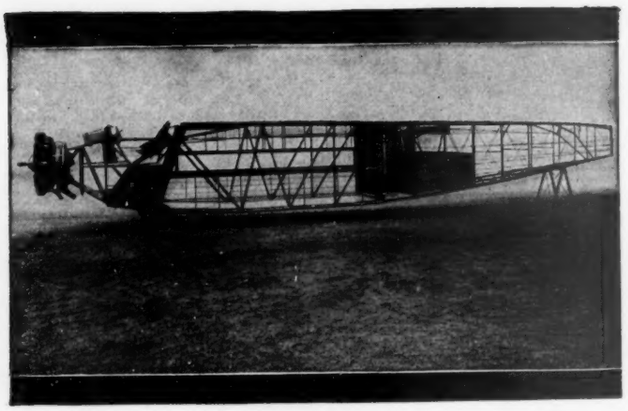

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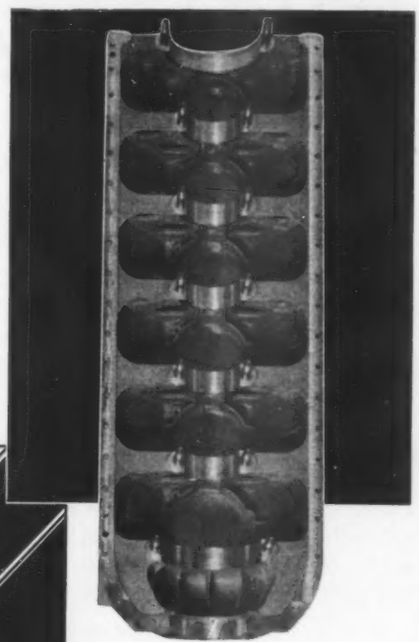

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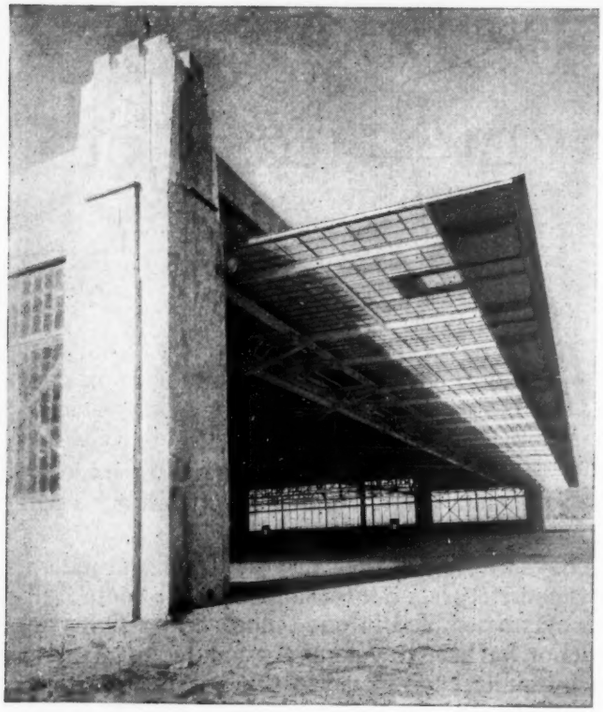

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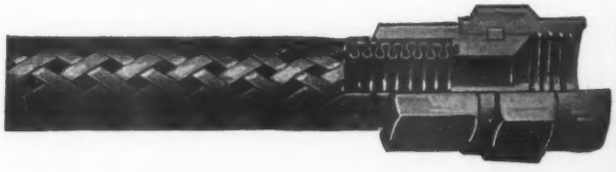

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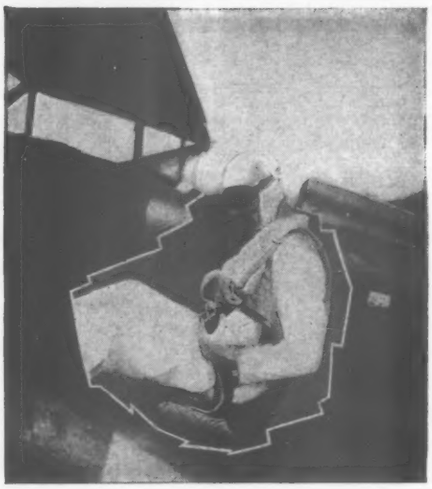

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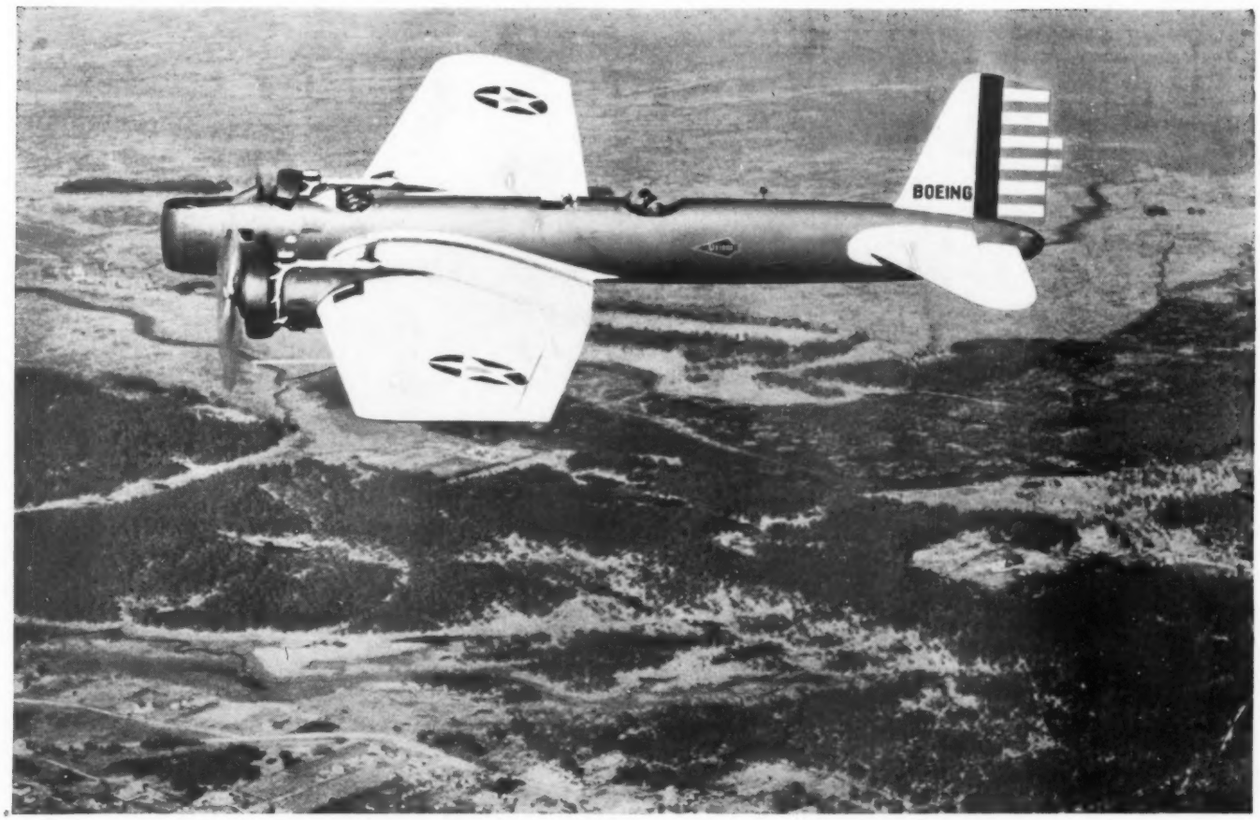


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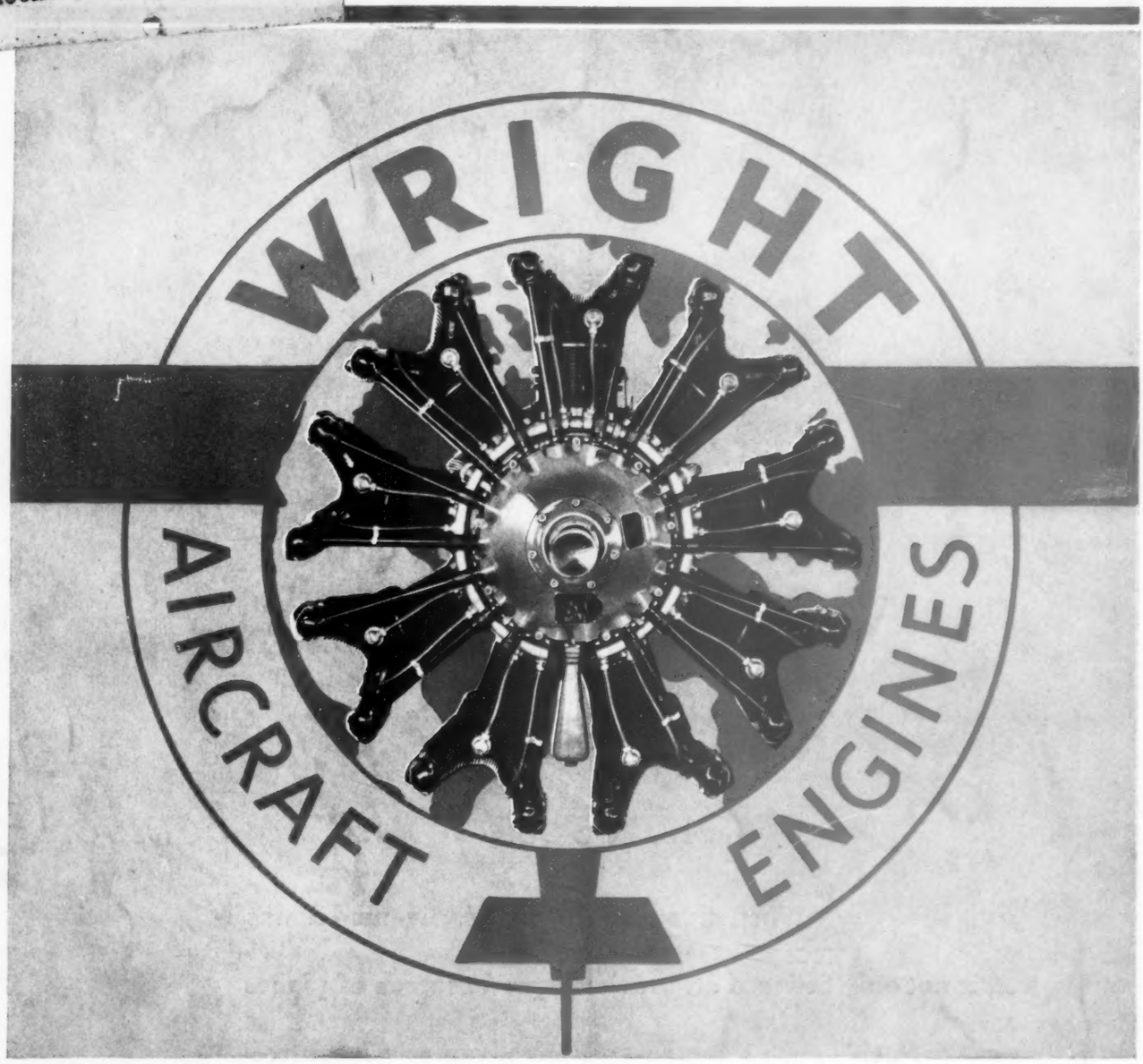


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